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FOREST PRODUCTION AND MARKETING OPPORTUNITIES FOR UTILIZING THE AVAILABLE TIMER RESOURCE IN COLORADO AND WYOMING

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FINAL REPORT

Forest Product Production and Marketing Opportunities for Utilizing the Available Timber Resource in Colorado and Wyoming

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Forest Product Production and Marketing Opportunities for Utilizing Available Timber Resources in Colorado and Wyoming

The Problem

Increasing the available timber supply is one of the primary objectives of forest management and improvement in wood utilization is one of the basic means of increasing the timber supply. It is estimated that the productivity of commercial forest lands could be doubled within 50 years if intensive forest management practices were adopted. A major deterrent to developing intensive forest management is the lack of markets for small-sized materials. It was estimated in 1970 that Colorado alone had 244,124,000 cubic feet of unutilized growth. Another waste in the utilization of wood fiber is volume of mill residues generated in lumber production. Excluding bark, about 55 percent of a sawlog is residue - approximately 10 percent sawdust, 10 percent shavings, and 35 percent chippable material.

The U.S. Forest Service, Colorado State Forest Service, and Wyoming State Forestry Division have identified the need to determine wood product marketing opportunities for the underutilized wood resources of Colorado and Wyoming. Viable markets need to be identified for mill residues and small timber removed from the thinning of overstocked stands. There is a definite need to promote wood product enterprises that are technically and economically feasible which will, in utilizing the large amount of underutilized wood fiber, improve management capabilities for timber as well as other multiple uses. Several wood product enterprises which offer potential to meet these needs are considered in this study including: a thermomechanical pulp mill (TMP), a wood energy enterprise, and a small, efficient, portable sawmill

located at a specific location(s).

The timber management and wood products marketing opportunities for the Southern Colorado Cluster need to be systematically analyzed to augment the analysis done under study RM-4251-21. These opportunities must be specified while considering various conditions involving mill production capabilities, raw material types, supplies, and availability, wood product technologies, and potential marketing areas.

The economic potential of National Forest lands currently classified by the USFS as "Marginal" should be analyzed with respect to their location within processing center timbersheds. Land areas and timber volumes need to be identified as well as the requirements necessary for making these Marginal Component lands economically available for each timbershed. Marginal lands are currently being scrutinized carefully as part of the new U.S. Forest Service planning process.

Problem Reference

This study has been identified and selected for research under problems1 and 4 of the Rocky Mountain Station Research work Unit Description FS-RM-4251.

Background

Study 4251-18, Assessment of Wood Raw Materials and Wood Utilization Potential for the Lodgepole Pine and Spruce-Fir Types in Colorado and Wyoming, developed figures for timber availability which for National Forest lands included only the Standard and Special Component. This study now needs to be augmented to include acreage and volumes of timber species in the Marginal Component of national forest lands in Colorado and Wyoming to estimate requirements for making these Marginal Component lands economically available for each timbershed.

The National Forest Management Act of 1976, Section 7(k) states..."The secretary shall identify lands within the management area which are not suited for timber production...." In part, this study will help in meeting this requirement by gathering information concerning these lands and relating it to specific processing center/timbershed situations. This will help to provide some estimate of the requirements necessary to make these lands economically available given a particular set of resource and market circumstances.

Study 4251-21, Production and Marketing Alternatives for Utilizing Lodgepole Pine in Colorado and Wyoming, analyzed timber management and wood product marketing opportunities for utilizing lodgepole pine and spruce-fir. Since Southwestern Colorado contains little lodgepole pine, that area was excluded from the above study and added to this study; which was augmented to include the southwestern cluster along with acreages and volumes for ponderosa pine.

Since a major deterrent to developing intensive forest management is the lack of markets for small-sized material resulting from thinnings, a wood energy enterprise was studied as a potential user of such material with the possibility that such an enterprise would provide an economical basis for such intensive forest management.

In recent years several new small and usually mobile sawmills have been developed. If these small sawmills are cost competitive with existing large sawmills, they offer significant advantages for timber management by permitting smaller volume sales. These sales would allow more intensive and localized management that would ordinarily be uneconomical for larger milling operations.

Viable markets for pulp chips from mill residues in Colorado and

Wyoming are declining due to increased transportation costs to Lake States markets. Construction of thermomechanical pulp mills within Colorado and Wyoming may offer an alternative use for such residues in future years. This process has advantages over kraft processing in that it can require less capital, has fewer pollution problems, and requires lower volumes of raw material and water for an economically sized mill. On a local basis, feasibility of a TMP mill hinges on the quality, quantity, and long term availability of mill residues for raw material and the availability of adequate markets. Although there would seem to be opportunities for such processing centers in Colorado and Wyoming, there had not been any preliminary type feasibility analysis.

Study Objectives

1. To estimate, from the best available data, the acreage and volumes of timber species in the Marginal Component of National Forest lands in Colorado and Wyoming and the requirements for making these Marginal Component lands economically available for each timbershed.
2. To identify timber management and wood product marketing opportunities, that support needed timber management for the southwestern area of Colorado.
3. To determine the general economic potential for three promising new industrial activities, a thermomechanical pulpmill, a wood energy enterprise, and a small efficient mobile sawmill operating in the lodgepole pine, ponderosa pine (SW Colorado) and spruce-fir types in Colorado and Wyoming.

Report Format

This report is subdivided into five sections. Section 1, Marginal Component Assessment, describes the acreage and timber volumes of Marginal Component land by procurement area. The potential for Marginal land as a source of timber supply is assessed considering current mill capacity, present

timber supply and the economics of cable logging.

Section 2, Southern Colorado Marketing Analysis, presents different scenarios concerning raw material supplies and market demand for this area. Each scenario is analyzed using linear programming to determine the best mix of products, their markets, and the most limiting constraints.

Section 3, Fuelwood Concentration Yards, points out the advantages and disadvantages of such an operation located in Colorado. An economic analysis of a particular operational mode is made to assess the costs involved and how they compare to current fuelwood and conventional fuel prices.

Section 4, Small Portable Sawmills, discusses the various types of portable mills, then shows the potential savings which might be accrued by using portable mills at the logging site. The effect of changing distance-to-the-site, timber sale size, and residue prices is analyzed quantitatively.

Section 5, Thermomechanical Pulp Mill, examines the general feasibility of such a mill in Colorado or Wyoming. Raw material supplies, markets, energy and transportation-to-market costs are considered in developing conclusions.

Since each section is essentially a different topic, they are formated with the references cited as footnotes within each chapter. Tables and figures are numbered consecutively within each chapter rather than sequentially throughout the entire report.

I. MARGINAL COMPONENT ASSESSMENT

Introduction

Timber lands within Colorado and Wyoming were divided into sixteen procurement areas to assess the acreages, timber volumes, and economic feasibility for development of the U.S. Forest Service Marginal Land Component. The major data source was the Timber Management Plans (TMP) and the Resource Planning Act (RPA) inventory data sheets for the national forests involved.

The definition of the Marginal Component includes a wide diversity of areas that may or may not all coincide with the focus of this study, that is the evaluation of these lands in terms of being suitable or unsuitable for timber harvesting. Section 2412.15 of the Forest Service Manual gives the following definition of the Marginal land classification:

> "This component of the regulated forest land includes areas not qualifying as standard or special components primarily because of excessive development costs, low product values or resource protection constraints. Included may be drainages requiring unusual logging techniques such as helicopters, areas where harvesting is blocked until government constructed roads are in place, or species type not presently in demand. Also included is the backlog of non-stocked areas that would otherwise be classed as standard, but are in need of reforestation but cannot be accomplished with Knutson-Vandenburg Act funds."

Within the above definition, the timber management plans utilized in this study include many interpretations of the Marginal Component that include, but are not limited to the following:

Access - Timber stands economically unavailable due to a lack of roads.

Erosion/Mass Land Movement/Unstable - Areas considered too unstable to permit harvesting using presently acceptable methods and equipment.

Logging Systems - Areas that cannot be logged with present logging equipment.

Non-Loggable Lands - Lands which, because of unstable soils and/or excessive slope, cannot be logged by methods currently in use on the working circle without acceptable watershed damage resulting.

Reforestation Backlog - Non-stocked or inadequately stocked commercial forest land.

Rockland - Areas on the border of noncommercial site classification due to shallow soil, slopes over 50% and a high percentage (50%) of rock outcrops or loose rocks greater than 12 inches in size.

Stagnated Lodgepole Pine - Lodgepole pine stands older than 70 years whose growth has stopped due to inadequate spacing.

Steep Slopes - Slopes exceeding a 40% grade.

Timber Stand Improvement (TSI) Backlog - Seedling - sapling stands for which precommercial thinning is not programmed for the 10 year period.

It is apparent that the Marginal Component figures used in this study may contain acreages which are not directly related to "loggability," e.g. Reforestation Backlog, Stagnated Lodgepole Pine, and Timber Stand Improvement Backlog. As a result the figures within this report may tend to overestimate the timber volumes which are classified as marginal and available for potential timber harvesting.

Inventory by Species and Stand Size

Each procurement area contains part of one or more National Forests and each National Forest has commercial forest land of which a percentage is defined as Marginal. Two simplifying assumptions were made in order to estimate the Marginal Component timber volume by species and stand size. The first assumption is that the area classified as Marginal is evenly distributed across each National Forest. The second assumption is that all timber volumes are evenly distributed by species and stand size across all commercial forest land components.

The first assumption allows use of an area adjustment factor (separate one for each national forest) to calculate acreage and timber volumes contained within each procurement area. This figure is the percent of national forest land contained within a procurement area as calculated in study RM-4251-18 titled, Assessment of Wood Raw Material and Wood Utilization Potential for the Lodgepole Pine and Spruce Fir Timber Types in Colorado and Wyoming.

The second assumption allows the calculation of a Marginal percent to be applied to timber volumes whenever they are not already broken down by land classification components in the TMP. The Marginal percent is the ratio of area classified as Marginal to the total area classified as commercial forest land. This percentage is applied to total acres and timber volumes by species and stand size to derive figures for acres/volumes for the Marginal Component.

Assessment for Potential Timber Harvesting on the Marginal Component

In order to assess the potential for timber harvesting on the marginal component several criteria were examined for each procurement area.

1) The percent of standard and special component contained within the RARE II study areas. This represents a potential loss of available timber supply if this area becomes included into the National Wilderness Preservation System.
2) The percent of the current programmed allowable cut that is actually cut.
3) The percent of the potential yield from the Standard and Special Component areas that is currently cut.
4) The percent of total commercial forest land within each procurement area classified as Marginal.
5) The percent of full time mill production capacity that the mills are presently using.

Items 1 through 5 correspond to the columns in Table I-1. This table will be referred to in each separate procurement area evaluation. The percent of commercial forest land classified as Marginal is a weighted average of the amount of each National Forest that is classified as Marginal within each procurement area. The remainder of the data was derived from available information in RM-4251-18.

Economic Evaluation of Logging Marginal Lands

The methods of harvesting timber on Marginal lands may be quite varied. Assuming that the part of the Marginal Component of interest is on steep slopes and/or involves fragile and rocky soil, a cable yarding operation will ordinarily be considered necessary.

Empirical cost/productivity data for cable yarding within the Colorado and Wyoming area is unavailable. At present the high capital and operating cost associated with cable yarding, combined with the overall smaller timber

size in this region, have made the operation cost prohibitive. However, preparations are being made for studying cable yarding of marginal lands in the Rocky Mountains.

Until empirical data can be assembled a rough cost analysis may be made using the following assumptions:[1/]

1) The operation will consist of one yarder with operator, one chaser, two chokesetters, and one part-time worker assisting with laying out cable lines.

2) The daily operating expense will range from $1000-$1500 per day.

3) The productivity will range from 150 to 300 pieces per day.

Further, conditions concerning tree density, defect and volume/acre are assumed to be the same on marginal component land as they are on the standard and special component. The only variable difference is the slope of the area. Using these costs and production assumptions, an average cable skidding cost figure per piece of timber can be derived from the following assumptions:

1) The average cost of operation is $1250.00/day.

2) The average number of pieces yarded is 225 pieces/day.

This will yield an average cost per piece of $5.55/piece of timber.

The costs of skidding and loading are found in the timber sales appraisal sheets for each procurement area. These cost figures per MBF were summed by cluster, averaged and then calculated to 1980 prices.[2/]

[1/] The above assumptions came from a telephone conversation with M. J. Gonsior at the Intermountain Experiment Station in Missoula, Montana.

[2/] U.S. Bureau of the Census, Statistical Abstract of the United States: 1979. (100 Edition) Washington, D.C., 1979. Page 479. Producer Price Indexes, by Commodities.

A cluster represents at least two contiguous processing centers. Due to insufficient data from some processing centers, the cluster approach was utilized to aggregate stumpage and procurement costs. For example, the Colorado-Wyoming cluster contains the Walden, Larimer-Foxpark, Saratoga, and Craig-Meeker procurement areas. The average skidding and loading cost was $32.44/MBF and the average felling and bucketing cost was $17.72/MBF.

The West Central Colorado cluster contains the Delta-Montrose, Eagle-Rifle-Glenwood Springs, and Granby-Fraser-Kremmling procurement areas. The average skidding and loading cost was $30.39/MBF and the average felling and bucking cost was $12.18/MBF.

The Southern Colorado cluster contains the Monte Vista-South Fork, Durango-Dolores, and Pagosa Springs procurement areas. The average skidding and loading cost was $33.04/MBF and the average felling and bucking cost was $13.09/MBF.

The North Central Wyoming cluster contains the Cody and Buffalo-Sheridan procurement areas. The average skidding and loading cost was $34.59/MBF and the average felling and bucking cost was $18.88/MBF.

The Western Wyoming cluster contains the Dubois, Pinedale, Afton-Freedom-Alpine, and Evanston procurement areas. The average skidding and laoding cost was $28.54/MBF and the average felling and bucking cost was $16.22/MBF.

The average of these cluster figures for felling and bucking and skidding and loading costs has been used in this analysis, as follows:

	1977 Prices	Jan, 1980 Prices[1/]
1) Felling and bucking cost	$15.62/MBF	$21.49/MBF
2) Skidding and loading cost	$31.80/MBF	$43.76/MBF

1/ Survey of Current Business, February 1980/Vol. 60, No. 2. Lumber and Products Wholesale Price Index, Boards - #2 and better.

Loading costs were not part of the cable system costs, therefore to separate the skidding from the loading costs a figure of 77%[2/] was applied to $43.76 to get $33.70/MBF for skidding alone. A 12% adjustment was also made to the felling and bucking costs[3/] to find that cost where steep slopes are involved, i.e. the marginal lands.

The average size of timber that must be harvested on Marginal land to equal average harvesting costs on the Standard and Special land can now be calculated:

	Standard and Special Lands	Marginal Lands
Skidding costs	$33.70/MBF	$5.55/piece
Felling and Bucking Costs	$21.49/MBF	$24.07/MBF

(marginal land costs) $5.55/piece x #pieces/MBF + $24.97/MBF = (standard and special land costs) $33.70/MBF + $21.49/MBF.

therefore, MBF /piece = $5.55/ [$55.19-$24.97] = .184 MBF/piece. This is the average size piece on Marginal lands that would produce unit costs equal to the average for Standard and Special Components. Assuming that the length of a log yarded were 16 feet, a diameter of slightly more than 17 inches would be necessary to make harvesting costs on marginal lands equal to the harvesting costs on Standard or Special lands. Using the above data, assumptions, and the 17" breakeven point the following table was formulated:

2/ USFS Appraisal Manual, 2420 Appraisal Bulletin No. 77-;/ Table II, Central Rocky, Group I and II, and Northern Rocky.

3/ IBID, Table IV.

Avg. diameter per piece (16 ft. logs)	Logging costs%, Marginal lands vs. Standard and Special lands
12"	+ 71
14"	+ 37
16"	8
17+"	0
18"	- 7
20"	- 19
22"	- 24
24"	- 30

Everything else being equal, the above table shows how much more (or less) expensive it would be to skid, fell, and buck timber on marginal lands with steep slopes (60%-70%) given the average size of timber to be harvested. The negative values for the large diameter log means that it is more economical to harvest the large timber on steep slopes than to harvest the smaller "average" sized timber on the less steep Standard and Special land components.

An effective cost comparison between existing harvesting methods and cable yarding systems cannot be made until an actual cable yarding system is studied in the Colorado-Wyoming area. The preceding analysis can only be used as a general guideline to evaluate the timber conditions necessary for economical logging of marginal component lands.

Analysis by Procurement Area

Walden Procurement Area

The approach used to generate all relevant data for the Walden procurement area will be the same procedure used for the remainder of the procurement areas. Since this is the first procurement area assessed, a detailed derivation of all calculations used will be presented here. Subsequent evaluations will include a discussion of the figures only, not details concerning their calculations.

The Walden procurement area contains part of the Routt National Forest. The percentage of the Routt contained within this procurement area was derived by using a dot grid to measure the acreage lying within the procurement area boundary. This was found to be 31.29%[1/].

The percentage of commercial forest land within the Routt National Forest classified as Marginal was developed from data in the Routt's Timber Management Plan (TMP), 1975; Page 3. The total commercial forest land acreage is the sum of the Standard, Special, Marginal, and Unregulated components which equals 738,100 acres. The total acreage for the Marginal Component is 99,300 acres. The Marginal percent is therefore 99,300 ÷ 738,100 = 13.5 %.

Land area and timber volumes by species and stand size were found in tables 5.41 and 5.43 on page 27 of the Routt National Forest's TMP. To obtain the Marginal land acreage contained within the Walden procurement area these figures were multiplied by the Marginal percent and then by the area adjustment factor. For example, the area of lodgepole pine sawtimber within the

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1/ Assessment of Wood Raw Material and Wood Utilization Potential for the Lodgepole Pine and Spruce-Fir Timber Types in Colorado and Wyoming, P. 65

Marginal Component of the Walden procurement area is 122,818 acres x .1345 x .3129 = 5,169 acres. These results are given in table I-2.

The same approach is used for timber volumes. Sawtimber volumes are to be expressed in thousand cubic feet (MCF) and have to be adjusted if the figures are given in thousand board feet (MBF) by a factor of 5 MBF equals 1 MCF. Using the same example of lodgepole sawtimber the volume contained within the marginal component of this procurement area is 1,421 MMBF x 1 MCF/ 5 MBF x .1345 x .3129 = 11,961 MCF.

The mortality calculations for timber volumes came from table C-14 of the Routt's TMP. Again, using lodgepole pine sawtimber as an example, there is 10 cubic feet mortality lost per acre per year. Applying this figure to the acres previously determined by lodgepole pine sawtimber yields 10 Ft^3/acre x 5,169 acres x 1 MCF/1000 Ft^3 = 52 MCF.

The potential yield information is separated into standard, special, and marginal components on page 1 of the Routt's TMP. This information is for a ten year period. This potential yield figure is adjusted by using the area adjustment factor and then dividing by 10 to derive an annual figure. The total volume is the sum of the sawtimber and "products" columns in the TMP in cunits (cunit = 100 MCF). For example, the potential yield acreage in the marginal component of the Walden procurement area is 46,500 acres x .3129 ÷ 10 years = 1,455 acres/year and for volumes is (527.5 cunits sawtimber + 204 cunits products) x 100 MCF/cunit x .3129 ÷ 10 years = 2289 MCF/year.

The percent of Standard and Special lands included in RARE II, shown in table I-1, is found on page 66 of RM-4251-18. The percentage of programmed allowable cut actually harvested is calculated from information on page 73, table I-3, RM-4251-18, actual cut ÷ programmed allowable cut = 860.82 ÷ 1374 = 62.6%

The percent of potential yield actually harvested is also calculated from information on page 73, table I-3, RM-4251-18. Actual cut ÷ potential yield = 860.82 ÷ 3360 = 25.6%.

The percent of full time mill capacity production actually utilized is calculated from information on page 75, table I-6, Final Report on Study RM-4251-18. MBF actual production ÷ MBF full time capacity production = (5 + 1,000 + 20,000 + 95) ÷ (60 + 1,200 + 22,800 + 1,140) = 83.7%.

The percent of commercial forest land that is Marginal is calculated by dividing the acres classified Marginal within the procurement area by the total commercial forest land acres within this procurement area,. 100 (99,300 Marginal acres x .3129) ÷ (738,100 x .3129) = 13.45%.

The figures in table I-1 indicate the mills are operating close to full capacity and are utilizing only one-fourth of the potential yield. If all the current mills operated at maximum production, there would still be ample timber supply within the Standard and Special Components and no real demand for timber on the Marginal lands. However, if all RARE II study areas were to become wilderness, 51%, then this may make Marginal lands more important to the timber supply base. Given the present situation, Marginal lands make up only a relatively small proportion, 13.5% of the CFL in the procurement area. Without a major decrease in the availability of timber from Standard and Special lands, it is unlikely that the Marginal lands would be an economic source of timber in this area.

TABLE I-1. Criteria for Assessing The Potential of Marginal Lands by Procurement Area

Procurement Area	Rare II%	Actual cut % of Programmed cut[1/]	Actual cut % of Potential Yield	Marginal % of CFL	Mill Capacity % of Potential Production
Walden	51%	62.6%	25.6%	13.5%	83.7%
Laramie Foxpark	34%				66.4%
Saratoga	51%	44.6%	20.7%	52.1%	87.5%
Craig-Meeker	79%	57.5%	25.2%	23.8%	79%
Delta Montrose	44%	30.4%	10.2%	32.3%	61.2%
Eagle-Rifle-Glenwood	69%	29.1%	24.3%	40.3%	84.8%
Granby-Fraser-Kremmling	42%	31.5%	16.5%	42.5%	66.3%
Monte Vista-South Fork	55%	48.2%	29.3%	39.0%	65.6%
Durango-Dolores	3%	193.3%	19.8%	39.3%	60.7%
Pagosa Springs	35%	193.2%	19.9%	39.3%	73.4%
Cody	36%	42.5%	16.2%	20.3%	74.4%
Buffalo-Sheridan	83%	52.3%	16.6%	26.4%	39.1%
Dubois	14%	140.5%	83.8%	8.3%	42.8%
Pinedale	24%	138.8%	85.1%	19.2%	47.3%
Afton-Freedom-Alpine	50%	370.7%	55.8%	15.2%	84.9%
Evanston	64%	85.3%	80.4%	12.6%	83.1%

[1/] Certain figures are greater than 100%. This occurs because the actual cut was greater than the programmed cut. These actual cut figures are based on 1976 production. The wood product demand was significant that year and firms cut more (past sales and new salvage sales) than is normally the case. Thus, these figures represent the uppermost percentages which would be likely to occur.

e I-1. Colorado: Timber Types, Processing Cen Procurement Areas, and Market Clusters.

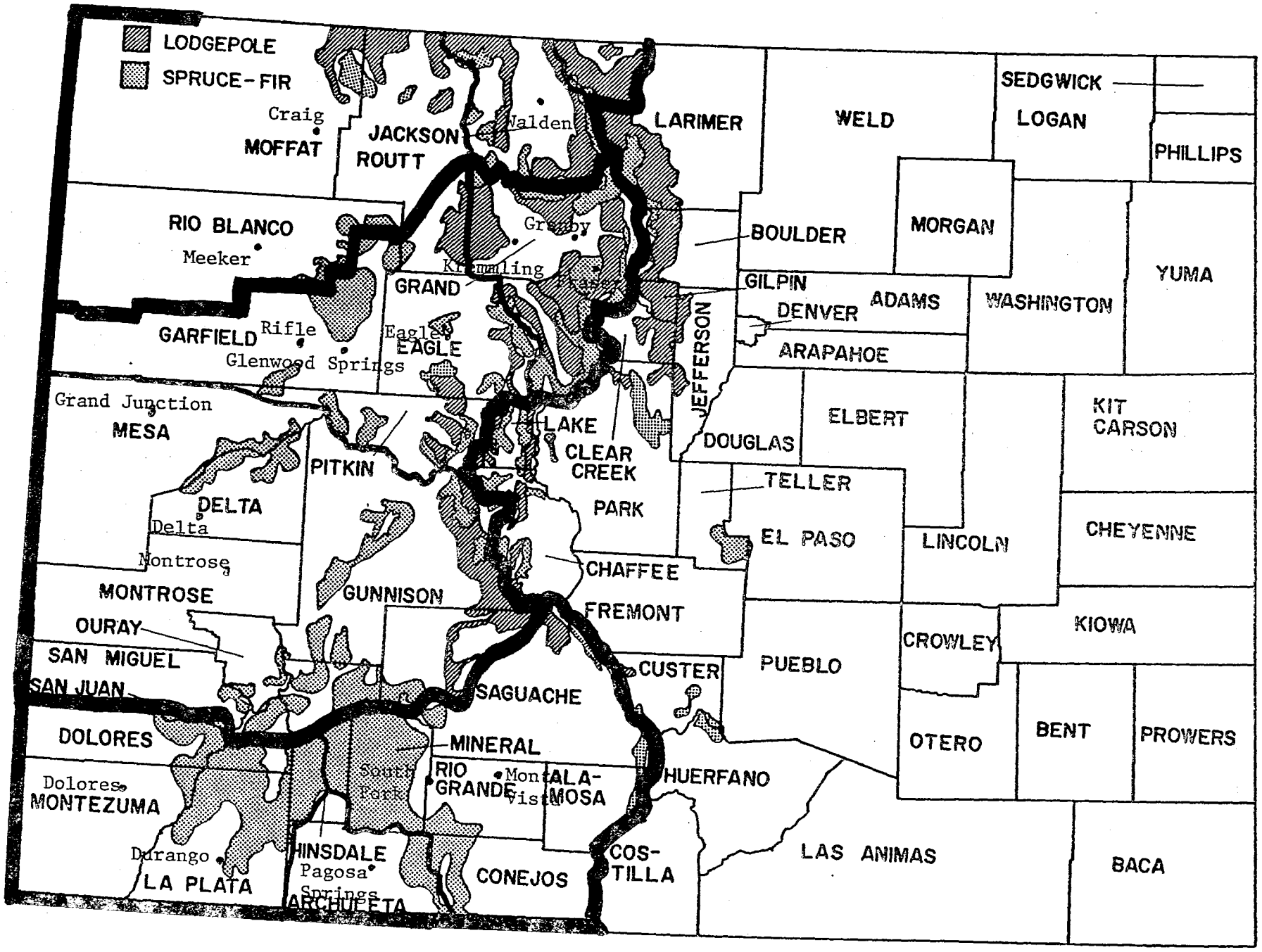
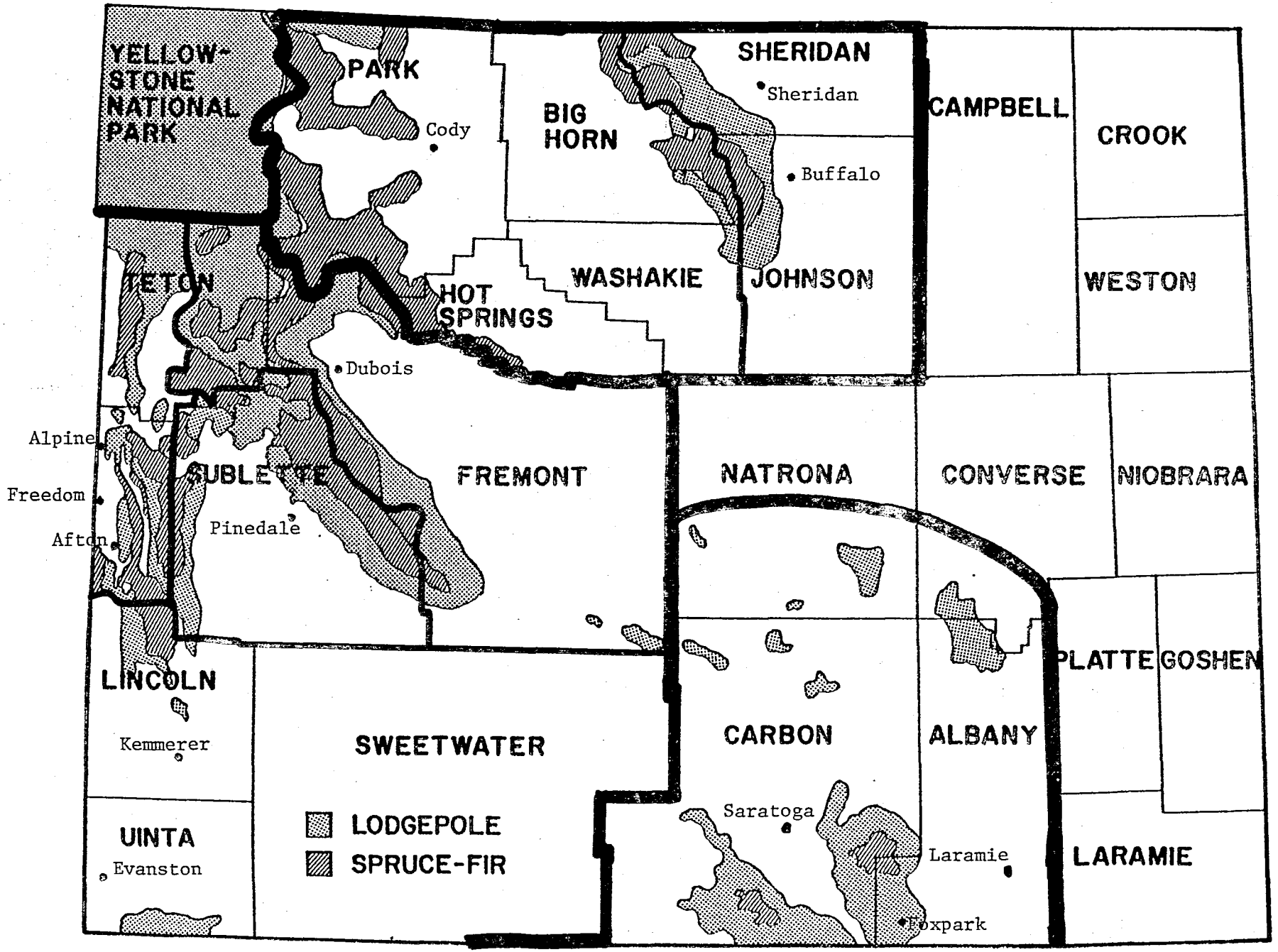


Figure I-2. Wyoming: Timber Types, Processing Centers/Procurement Areas, and Market Clusters.



Walden Procurement Area Marginal Land Figures

Routt N. F.

	Live Timber		Mortality		Live Timber		Mortality		
	Acres[1]	MCF[2]	Acres[1]	MCF[3]	Acres	MCF	Acres	MCF	
Sawtimber									
lodgepole pine	5,169	11,961	5,169	52					
spruce-fir	7,663	16,624	7,663	192					
Douglas-fir	361	379	361	13					
ponderosa pine	N/A	N/A	N/A	N/A					
white bark/ limber pine									
aspen	3,458	5,942	3,458	69					
Total Sawtimber	16,651	34,006	16,651	326					
Poletimber			Less than	sawtimber			Less than	sawtimber	
lodgepole pine	2,107	1,406	2,676	20					
spruce-fir	1,663	1,162	5,365	127					
Douglas-fir	N/A	0	N/A	3					
ponderosa pine	N/A	N/A	N/A	N/A					
white bark/ limber pine									
aspen	3,263	1,229	5,112	54					
Total Poletimber	7,033	3,797	13,153	204					
Seedling and Sapling			Potential yield[4]				Potential	yield	
lodgepole pine	569	346	1,455	2,289					
spruce-fir	3,702	682							
Douglas-fir	N/A	0							
ponderosa pine	N/A	N/A							
white bark/ limber pine									
aspen	1,849	446							
Total seedling & sapling	6,120	1,474							
Totals	29,804	39,217							

1/ TMP, Routt National Forest 1975-1985; P. 27, Part 5.41.

2/ TMP, Routt National Forest 1975-1985; P. 27, Part 5.43.

3/ TMP, Routt National Forest 1975-1985; Table C-14.

4/ TMP, Routt National Forest 1975-1985; P. 1.

Laramie-Foxpark Procurement Area

The Laramie-Foxpark procurement area contains parts of Medicine Bow and Arapahoe-Roosevelt National Forests, 36.86 percent of the Medicine Bow and 17.91 percent of the Arapahoe-Roosevelt are contained within this procurement area. The Arapahoe-Roosevelt timber management plan was not available when this report was completed.

Laramie-Foxpark Procurement Area Marginal Land Figures

	Medicine Bow National Forest				Arapahoe-Roosevelt National Forest			
	Live Timber		Mortality		Live Timber		Mortality	
	Acres[1]	MCF[2]	Acres[1]	MCF[3]	Acres	MCF	Acres	MCF
Sawtimber								
lodgepole pine	2,816	7,078	2,816	14	Not presently available			
spruce-fir	30,506	78,508	30,506	541				
Douglas-fir	N/A	N/A	N/A	N/A				
ponderosa pine	"	"	"	"				
white bark/ limber pine								
aspen	"	"	"	"				
Total Sawtimber	33,322	85,586	33,322	555				
			Less than	sawtimber			Less than	sawtimber
Poletimber								
lodgepole pine	15,597	41,758	34,440	192				
spruce-fir	4,155	18,396	10,450	49				
Douglas-fir	N/A	N/A	N/A	N/A				
ponderosa pine	"	"	"	"				
white bark/ limber pine								
aspen	"	"	"	"				
Total Poletimber	19,752	60,154	44,890	241				
			Potential	yield[4]			Potential	yield
Seedling and Sapling								
lodgepole pine	18,843	N/A	4,939	4,014				
spruce-fir	6,295	"						
Douglas-fir	N/A	"						
ponderosa pine	"	"						
white bark/ limber pine								
aspen	"	"						
Total seedling & sapling	25,138	"						
Totals	78,212	145,740						

1/ TMP, Medicine Bow National Forest 1975-1984; p. 17.

2/ Volumes were obtained from 1970 R.P.A. data.

3/ TMP, Medicine Bow National Forest 1975-1984; P. 25.

4/ TMP, Medicine Bow National Forest 1975-1984; 7th page in report (no page number, no table title).

Saratoga Procurement Area

The Saratoga procurement area contains 45.6% of the Medicine Bow National Forest. A fairly high percentage of the Medicine Bow is classified marginal land, 52%.

The present mills in the area can operate at near full capacity and require only a fairly small portion of the programmed cut and potential yield (Table I-1). Unless new capacity is developed, it does not seem likely that the marginal lands would be an important economic source of timber. However, the RARE II study areas include half of the standard and special components. Therefore, if major wilderness setasides occurred in this area, the marginal lands could become more important as a source of raw material. This is particularly true given the total amount of marginal acreage and volumes involved in this procurement area.

Saratoga Procurement Area-Marginal Land Related Figures

Medicine Bow National Forest

	Live Timber		Mortality		Live Timber		Mortality	
	Acres[1]	MCF[2]	Acres[1]	MCF[3]	Acres	MCF	Acres	MCF
Sawtimber								
lodgepole pine	35,139	87,527	35,139	173				
spruce-fir	37,723	97,080	37,723	669				
Douglas-fir	N/A	4,550	N/A	N/A				
ponderosa pine	"	10,036	"	"				
white bark/ limber pine	"	N/A	"	"				
aspen	"	3,355	"	"				
Total Sawtimber	72,862	202,548	72,862	842				
			Less than	sawtimber			Less than	sawtimber
Poletimber								
lodgepole pine	19,287	54,328	42,587	238				
spruce-fir	5,138	27,545	12,923	61				
Douglas-fir	N/A	1,788	N/A	N/A				
ponderosa pine	"	1,132	"	"				
white bark/ limber pine	"	N/A	"	"				
aspen	"	10,490	"	"				
Total Poletimber	24,425	95,283	55,570	299				
			Potential yield[4]				Potential	yield
Seedling and Sapling								
lodgepole pine	23,300	N/A	6,113	4,967				
spruce-fir	7,785	"						
Douglas-fir	N/A	"						
ponderosa pine	"	"						
white bark/ limber pine								
aspen	"	"						
Total seedling & sapling	31,085	"						
Totals	128,372	297,831						

1/ TMP, Medicine Bow National Forest 1975-1984; P. 17

2/ Volumes were obtained from 1979 R.P.A. data.

3/ TMP, Medicine Bow National Forest 1975-1984; p. 25.

4/ TMP, Medicine Bow National Forest 1975-1984; 7th page in report (no page number, no table title).

Craig-Meeker Procurement Area

The Craig-Meeker Procurement Area contains 41.02 percent of the Routt National Forest area and 15.87 percent of the White River National Forest area. Of the commercial forest land 13.45 percent is classified marginal within the Routt and 47.14 percent of commercial forest land is classified marginal within the White River.

The actual timber harvested is about one-half of the programmed cut and one-fourth of the potential yield. With the mills operating at nearly 80 percent capacity there is no immediate demand to harvest timber in the marginal component. However, 80 percent of the standard and special components are contained in RARE II study areas (highest percentage of all procurement areas). Given these large possible setasides there could definitely be a future need for marginal lands to supply timber.

Craig-Meeker Procurement Area-Marginal Land Figures

	White River National Forest				Routt National Forest			
	Live Timber		Mortality		Live Timber		Mortality	
	Acres[1]	MCF[2]	Acres[2]	MCF[3]	Acres[5]	MCF[6]	Acres[5]	MCF[7]
Sawtimber								
lodgepole pine	7,222	17,943	7,222	141	6,776	15,680	6,776	68
spruce-fir	25,829	61,471	25,829	410	10,046	2,179	10,046	251
Douglas-fir	2,593	4,120	2,593	2	473	497	473	17
ponderosa pine	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
white bark/ limber pine	"	"	"	"	"	"	"	"
aspen	10,428	14,373	10,428	129	4,534	6,609	4,534	91
Total Sawtimber	46,072	97,907	46,072	682	21,829	24,965	21,829	427
			Less than	sawtimber			Less than	sawtimber
Poletimber								
lodgepole pine	1,968	8,003	2,278	18	2,763	1,843	3,508	26
spruce-fir	3,464	16,990	6,043	52	2,180	1,523	7,034	166
Douglas-fir	159	505	159	1	N/A	6	N/A	4
ponderosa pine	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
white bark/ limber pine	"	"	"	"	"	"	"	"
aspen	5,759	8,520	6,320	22	4,278	1,611	6,703	70
Total Poletimber	11,350	34,018	14,800	93	9,221	4,977	17,245	262
			Potential yield[4]				Potential	yield[8]
Seedling and Sapling								
lodgepole pine	310	N/A	2,285	2,522	745	452	1,907	3,001
spruce-fir	2,579	"			4,854	894		
Douglas-fir	0	"			N/A	0		
ponderosa pine	N/A	"			"	N/A		
white bark/ limber pine								
aspen	561	"			2,425	585		
Total seedling & sapling	3,450	"			8,024	1,931		
Totals	60,872	131,925			39,074	31,873		

1/ TMP., White River National Forest 1977-1987; p. 86.
2/ TMP., White River National Forest 1977-1987; p. 99.
3/ TMP., White River National Forest 1977-1987; p. 101, Table 13.
4/ TMP., White River National Forest 1977-1987; p. 2, Potential Yield Statement.
5/ TMP., Routt National Forest 1975-1985; p.27, Part 5.41.
6/ TMP., Routt National Forest 1975-1985; p.27, Part 5.43.
7/ TMP., Routt National Forest 1975-1985; Table C-14.
8/ TMP., Routt National Forest 1975-1985; p. 1, Potential Yield Statment.

Delta-Montrose Procurement Area

The Delta-Montrose procurement area contains the Grand Mesa-Uncompahgre and Gunnison National Forests. Both national forests are entirely contained within this procurement area with 25.57 % of commercial forest land classified marginal within the Grand Mesa-Uncompahgre and 41.74 percent of commercial forest land area and 28.08 percent of the timber volume classified marginal within the Gunnison. The two percent figures for the Gunnison are necessary because the acreage for timber type and stand size given in the TMP was for commercial forest land without the unregulated component and the volume figures were for the commercial forest land with the unregulated component included.

The actual cut is a small percentage of the programmed cut and potential yield. Even if the mills were operating at full capacity and all RARE II areas became wilderness, there would probably be little need to harvest timber within the marginal component. Of course, this is given the current mill capacity. It seems there are opportunities here for expansion of mill production capabilities. This is particularly true given the larger amount of acreages and volumes involved here.

It is also important to note that there is a potential for a dramatic increase in wood product demand due to energy related growth in the West-Central Colorado area. A large percentage of the energy related industrial and housing needs could be supplied by the local mills within this cluster.[1/]

1/ Page 212, Production and Marketing Alternatives for Utilizing Lodgepole Pine in Colorado and Wyoming.

Delta-Montrose Procurement Area Marginal Land Figures

	Gunnison National Forest				Grand-Mesa-Uncompahgre National Forest			
	Live Timber		Mortality		Live Timber		Mortality	
	Acres[1]	MCF[2]	Acres[1]	MCF[3]	Acres[5]	MCF[6]	Acres[5]	MCF[7]
Sawtimber								
lodgepole pine	37,040	53,833	37,041	206	N/A	N/A	N/A	N/A
spruce-fir	72,013	161,433	72,013	303	64,181	119,412	64,181	716
Douglas-fir	12,015	10,635	12,015	58	2,813	5,369	2,813	N/A
ponderosa pine	N/A	N/A	N/A	N/A	17,899	16,365	17,899	70
white bark/ limber pine	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
aspen	1,575	1,757	1,575	28	22,246	52,930	22,246	91
Total Sawtimber	122,644	227,658	122,644	595	107,139	194,076	107,139	877
			Less than	sawtimber			Less than	sawtimber
Poletimber								
lodgepole pine	24,621	10,330	41,149	136	N/A	N/A	N/A	N/A
spruce-fir	5,862	3,006	17,631	180	5,370	7,159	7,671	258
Douglas-fir	1,087	86	1,922	0	N/A	N/A	N/A	N/A
ponderosa pine	N/A	N/A	N/A	7	1,790	511	4,091	N/A
white bark/ limber pine	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
aspen	N/A	N/A	N/A	.53	35,542	18,666	40,400	355
Total Poletimber	31,570	13,422	60,702	476	42,702	26,336	52,162	613
			Potential yield[4]				Potential	yield[8]
Seedling and Sapling								
lodgepole pine	16,528	2,423	2,300	1,439	N/A	N/A	4,620	3,920
spruce-fir	11,769	4,428			2,301	256		
Douglas-fir	835	524			N/A	N/A		
ponderosa pine	N/A	N/A			2,301	N/A		
white bark/ limber pine	N/A	N/A						
aspen	N/A	N/A			4,858	1,023		
Total seedling & sapling	29,132	7,375			9,460	1,279		
Totals	183,346	248,455			159,301	221,691		

1/ TMP., Gunnison National Forest 1975-1985; p. 39, Table 9.
2/ TMP., Gunnison National Forest 1975-1985; p. 41, Table 11.
3/ Volumes were obtained from 1979 RPA data.
4/ TMP., Gunnison National Forest 1975-1985; p. VI.
5/ TMP., Grand Mesa-Uncompahgre 1975-1985; p. 32, Table 6.
6/ TMP., Grand Mesa-Uncompahgre 1975-1985; p. 36, Table 9.
7/ Volumes were obtained from 1979 RPA data.
8/ TMP., Grand Mesa-Uncompahgre 1975-1985; p. VI

Eagle-Rifle-Glenwood Springs Procurement Area

The Eagle-Rifle-Glenwood Springs procurement area contains 24.41 percent of the Routt National Forest and 84.13 percent of the White River National Forest. The percentage of commercial forest land classified as marginal is 13.45 percent for the Routt and 47.14 percent for the White River.

The actual cut is roughly one-fourth of the programmed cut potential yield with the mills operating close to potential capacity. Given the present mill capacity and the RARE II setasides, there would seem to be little chance of a supply deficit making it necessary to harvest timber within the marginal component. However, the marginal component does represent a fairly large percentage of the CFL. Such a large percentage may warrant consideration of such areas in the future. There is a large acreage and volume involved here which might make it economical to invest in more expensive cable systems. It is important also to note here there is a potential for an increase in wood product demand due to energy related growth in the West-Central Colorado area. A large percentage of the energy related industrial and housing lumber needs could be supplied by the local mills within this cluster in which this procurement area is contained.[1/]

1/ Page 212, Production and Marketing Alternatives for Utilizing Lodgepole Pine in Colorado and Wyoming.

Eagle-Rifle-Glenwood Springs Procurement Area-Marginal Land Figures

	White River National Forest				Routt National Forest			
	Live Timber		Mortality		Live Timber		Mortality	
	Acres[1]	MCF[2]	Acres[1]	MCF[3]	Acres[5]	MCF[6]	Acres[5]	MCF[7]
Sawtimber								
lodgepole pine	38,283	201,781	38,283	747	4,032	11,845	4,032	40
spruce-fir	136,926	69,128	136,926	2,171	5,978	12,968	5,978	149
Douglas-fir	13,747	46,327	13,747	12	281	295	281	10
ponderosa pine	N/A	N/A	N/A		N/A	N/A	N/A	N/A
white bark/ limber pine	N/A	N/A	N/A		N/A	N/A	N/A	N/A
aspen	55,284	161,632	55,284	683	2,698	3,933	2,698	54
Total Sawtimber	244,240	478,868	244,240	3,613	12,989	29,041	12,989	253
Poletimber			Less than	sawtimber			Less than	sawtimber
lodgepole pine	10,432	89,996	12,075	92	1,644	1,096	2,087	16
spruce-fir	18,362	191,069	32,031	273	1,297	906	4,185	98
Douglas-fir	843	5,677	843	5	N/A	0	N/A	2
ponderosa pine	N/A	N/A	N/A	N/A	N/A	N/A		N/A
white bark/ limber pine	N/A	N/A	N/A	N/A	N/A	N/A		N/A
aspen	30,526	95,814	33,498	116	2,545	959	3,988	42
Total Poletimber	60,163	382,556	78,447	486	5,486	2,961	10,260	158
Seedling and Sapling			Potential yield[4]				Potential	yield[8]
lodgepole pine	1,643	N/A	12,165	13,377	443	269	1,135	1,786
spruce-fir	13,669	N/A			2,883	532		
Douglas-fir	N/A	N/A			N/A	N/A		
ponderosa pine	N/A	N/A			N/A	N/A		
white bark/ limber pine								
aspen	2,972	N/A			1,443	348		
Total seedling & sapling	18,284	N/A			4,774	1,149		
Totals	322,687	861,424			23,249	33,151		

1/ TMP., White River National Forest 1977-1987; p. 86.
2/ TMP., White River National Forest 1977-1987; p. 99.
3/ TMP., White River National Forest 1977-1987; p. 101, Table 13.
4/ TMP., White River National Forest 1977-1987; p. 2, Potential Yield Statement.
5/ TMP., Routt National Forest 1975-1985; p. 27, Part 5.41.
6/ TMP., Routt National Forest 1975-1985; p. 27, Part 5.43.
7/ TMP., Routt National Forest 1975-1985; Table C-14.
8/ TMP., Routt National Forest 1975-1985; p. 1, Potential Yield Statement.

Granby-Fraser-Kremmling Procurement Area

The Granby-Fraser-Kremmling procurement area contains the entire Arapaho portion of the Arapaho-Roosevelt National Forest and 3.28 percent of the Routt National Forest. The percentage of commercial forest land classified as marginal is 48.08 percent for the Arapaho and 13.45 percent for the Routt.

Tha actual cut is only one-sixth of the potential yield and one-third of the programmed cut with the mills operating at two-thirds capacity. If the mills were to operate at full capacity and all RARE II areas were to become wilderness, there would seem to be no need to harvest timber within the marginal component. There is a large amount of marginal land in this area, 42.5% of the CFL. This is the largest percentage of any of the procurement areas. Therefore, in terms of the proportional amount of such lands, this area has the greatest potential level of supply from the Marginal Component.

The energy developments could also have an impact on production in this area.

Granby-Fraser-Kremmling Procurement Area-Marginal Land Figures

	Routt National Forest				Arapaho National Forest			
	Live Timber		Mortality		Live Timber		Mortality	
	Acres[1]	MCF[2]	Acres[1]	MCF[3]	Acres[5]	MCF[6]	Acres[5]	MCF[7]
Sawtimber								
lodgepole pine	542	1,254	542	5	93,846	220,910	93,846	507
spruce-fir	803	1,743	803	20	85,237	227,050	85,237	1,549
Douglas-fir	38	40	38	1	N/A	N/A	N/A	N/A
ponderosa pine	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
white bark/ limber pine					N/A	N/A	N/A	N/A
aspen	363	529	363	7	N/A	N/A	N/A	N/A
Total Sawtimber	1,746	3,566	1,746	37	179,083	487,796	179,083	2,056
			Less than	sawtimber			Less than	sawtimber
Poletimber								
lodgepole pine	221	147	221	2	34,900	70,428	43,411	823
spruce-fir	174	122	174	4	5,981	10,281	14,739	232
Douglas-fir	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
ponderosa pine	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
white bark/ limber pine					N/A	N/A	N/A	N/A
aspen	342	129	342	3	N/A	N/A	N/A	N/A
Total Poletimber	737	398	737	9	40,881	80,709	58,150	1,055
			Potential	yield[4]			Potential	yield[8]
Seedling and Sapling								
lodgepole pine	60	36	153	240	8,511	N/A	7,060	17,270
spruce-fir	388	71			8,758	N/A		
Douglas-fir	N/A	N/A			N/A	N/A		
ponderosa pine	N/A	N/A			N/A	N/A		
white bark/ limber pine					N/A	N/A		
aspen	193	47			N/A	N/A		
Total seedling & sapling	641	154			17,269	N/A		
Totals	3,k24	4,118			237,233	568,600		

1/ TMP., Routt National Forest 1975-1985; p. 27, Part 5.41.
2/ TMP., Routt National Forest 1975-1985; p. 27, Part 5.43.
3/ TMP., Routt National Forest 1975-1985; Table C-14.
4/ TMP., Routt National Forest 1975-1985; p. 1, Potential Yield Statement.
5/ TMP., Arapaho National Forest 1975-1985; p. 51a.
6/ TMP., Arapaho National Forest 1975-1985; p. 57, Table 8A
7/ TMP., Arapaho National Forest 1975-1985; p. 59.
8/ TMP., Arapaho National Forest 1975-1985; p. 1, Potential Yield Statement.

Monte Vista-South Fork Procurement Area

The Monte Vista-South Fork procurement area contains the entire Rio Grande National Forest. The percent of commercial forest land classified as marginal is 39.03 percent and 27.41 percent of the timber volumes are on marginal lands. The two percent figures result from the same reasons discussed for the Gunnison National Forest in the Delta-Montrose procurement area.

The actual cut is roughly 30 percent of the potential yield and 50 percent of the programmed cut with the mills operating at two thirds of their potential capacity. If the mills were to operate at full capacity and all RARE II areas (55%) were to become wilderness, the full supply via standard and special components could be utilized. Therefore in this case, the marginal component may require close examination as to its potential for timber supply. This is particularly important here since the marginal lands makeup almost 40% of the total CFL and include large amounts of acreages and volumes.

Monte Vista-South Fork Procurement Area-Marginal Land Figures

Rio Grande National Forest

	Live Timber		Mortality		Live Timber		Mortality		
	Acres[1]	MCF[2]	Acres[1]	MCF[3]	Acres	MCF	Acres	MCF	
Sawtimber									
lodgepole pine	2,624	853	2,624	0					
spruce-fir	116,955	199,443	116,955	1,214					
Douglas-fir	26,624	19,167	26,624	44					
ponderosa pine	0	N/A	0	0					
white bark/ limber pine	N/A	11,176	N/A	0					
aspen	N/A	16,680	N/A	0					
Total Sawtimber	146,203	247,315	146,203	1,258					
Poletimber			Less than	sawtimber			Less than	sawtimber	
lodgepole pine	28	N/A	4,621	0					
spruce-fir	18,004	10,769	3,229	211					
Douglas-fir	7,640	1,625	7,640	0					
ponderosa pine	N/A	N/A	N/A	0					
white bark/ limber pine	N/A	N/A	N/A	N/A					
aspen	N/A	5,831	N/A	156					
Total Poletimber	25,672	17,725	44,490	367					
Seedling and Sapling			Potential	yield[4]			Potential	yield	
lodgepole pine	4,593	931	4,450	3,584					
spruce-fir	14,225	4,017							
Douglas-fir	N/A	N/A							
ponderosa pine	N/A								
white bark/ limber pine									
aspen	N/A	1,921							
Total seedling & sapling	1,888	6,869							
Totals	190,693	271,909							

1/ TMP., Rio Grande National Forest 1974-1984; p. 25, Table 4.
2/ TMP., Rio Grande National Forest 1974-1984; p. 27, Table 7.
3/ Volumes were obtained from 1979 RPA data.
4/ TMP., Rio Grande National Forest 1974-1984; p. V.

Durango-Dolores Procurement Area

The Durango-Dolores procurement area contains 63.44 percent of the San Juan National Forest with 39.25 percent of its commercial forest land classified as marginal.

The actual cut only one-fifth of the potential yield. This occurred under conditions where the actual harvest was almost double the programmed cut. This was a result of a very strong demand for wood products that year, 1976. The mills are operating at nearly two-thirds capacity under these conditions. There is a large amount of present mill capacity. Most notable is the small percentage of RARE II study areas contained within the procurement area, only 3%. Thus, with the mills operating at full capacity, and all RARE II areas becoming wilderness there would still remain a potentially large supply of timber available within the standard and special components. Given the present mill capacity this would make the marginal component an unlikely area for timber harvesting. However, there is a large acreage of marginal land (more than any other procurement area) making it, in terms of absolute amounts, a major possible source if the economic conditions become favorable.

Durango-Dolores Procurement Area-Marginal Component Figures

	San Juan National Forest								
	Live Timber		Mortality		Live Timber		Mortality		
	Acres[1]	MCF[2]	Acres[1]	MCF[3]	Acres	MCF	Acres	MCF	
Sawtimber									
lodgepole pine	0	0	0	0					
spruce-fir	121,995	292,707	121,995	941					
Douglas-fir	78,983	87,798	78,983	99					
ponderosa pine	42,695	57,345	42,695	45					
white bark/ limber pine									
aspen	N/A	31,299	N/A	152					
Total Sawtimber	243,673	469,144	243,673	1,237					
Poletimber			Less than	sawtimber			Less than	sawtimber	
lodgepole pine	0	0	0	0					
spruce-fir	5,519	5,254	5,519	101					
Douglas-fir	12,878	12,798	12,878	17					
ponderosa pine	0	0	0	0					
white bark/ limber pine									
aspen	N/A	43,625	N/A	47					
Total Poletimber	18,398	61,677	18,398	165					
Seedling and Sapling			Potential yield[4]				Potential	yield	
lodgepole pine	0	0	17,128	15,109					
spruce-fir	2,347	6,101							
Douglas-fir	1,205	647							
ponderosa pine	0	0							
white bark/ limber pine									
aspen	N/A	2,440							
Total seedling & sapling	3,553	9,188							
Totals	265,624	540,009							

1/ TMP., San Juan National Forest 1976-1986; Appendix D.
2/ TMP., San Juan National Forest 1976-1986; Appendix C, p. 3 of 4.
3/ Volumes were obtained from 1979 RPA data.
4/ TMP., San Juan National Forest 1976-1986; p. 1.

Pagosa Springs Procurement Area

The Pagosa Springs procurement area contains 36.56 percent of the San Juan National Forest area with 39.25 percent of its commercial forest land classified as marginal.

The actual cut is only one-fifth of the potential yield. The mills are operating at three-fourths capacity. If the mills were operating at full capacity and all 35 percent of the area within the RARE II area became wilderness, the standard and special components could easily meet the timber harvesting demand under a potential yield program. However, without a potential yield program for the standard and special lands, the marginal component could be called upon as a source of timber supply.

Pagosa Springs Procurement Area

San Juan National Forest

	Live Timber		Mortality		Live Timber		Mortality		
	Acres[1/]	MCF[2/]	Acres[1/]	MCF[3/]	Acres	MCF	Acres	MCF	
Sawtimber									
lodgepole pine	0	0	0	N/A					
spruce-fir	70,304	16,868	70,304	941					
Douglas-fir	45,517	5,060	45,517	98					
ponderosa pine	24,604	3,305	24,604	44					
white bark/ limber pine									
aspen	0	1,804	0	152					
Total Sawtimber	140,425	27,037	140,425	1,235					
			Less than	sawtimber			Less than	sawtimber	
Poletimber									
lodgepole pine	0	0	0	N/A					
spruce-fir	3,181	303	4,534	101					
Douglas-fir	7,422	738	8,117	17					
ponderosa pine	0	0	0	0					
white bark/ limber pine									
aspen	0	2,514	0	47					
Total Poletimber	10,603	3,555	12,651	165					
			Potential	yield[4/]			Potential	yield	
Seedling and Sapling									
lodgepole pine	0	0	9,871	8,707					
spruce-fir	1,353	352							
Douglas-fir	695	37							
ponderosa pine	0	0							
white bark/ limber pine									
aspen	0	141							
Total seedling & sapling	2,048	530							
Totals	153,076	31,122							

1/ TMP., San Juan National Forest 1976-1986; Appendix D.
2/ TMP., San Juan National Forest 1976-1986; Appendix C. p. 3 of 4.
3/ Volumes were obtained from 1979 RPA data.
4/ TMP., San Juan National Forest 1976-1986; p. 1.

Cody Procurement Area

The Cody procurement area contains 34.79 percent of the Bighorn National Forest and 64.37 percent of the Shoshone National Forest . The percent of commercial forest land classified as marginal is 26.41 percent for the Bighorn and 6.52 percent for the Shoshone.

The actual cut is 16% of the potential yield and 40% of the programmed cut with the mills operating at three-fourths potential capacity. With the mills operating at full capacity and all RARE II areas becoming wilderness, there would still seem to be a sufficient timber supply within the standard and special components. It seems unlikely without additional mill capacity that the more expensive-to-low marginal lands would be actively sought for timber supply.

Cody Procurement Area

	Shoshone National Forest				Bighorn National Forest			
	Live Timber		Mortality		Live Timber		Mortality	
	Acres[1]	MCF[2]	Acres[1]	MCF[3]	Acres[5]	MCF[6]	Acres[5]	MCF[7]
Sawtimber								
lodgepole pine	2,711	5,661	2,711	2	10,142	27,178	10,142	103
spruce-fir	3,173	8,285	3,173	11	12,138	27,407	12,138	68
Douglas-fir	3,723	5,610	3,723	2	0	5,935	0	12
ponderosa pine	N/A	N/A	N/A	N/A	673	423	673	1
white bark/ limber pine	N/A	N/A	N/A	N/A	0	N/A	0	
aspen	N/A	N/A	N/A	N/A	0	46	0	N/A
Total Sawtimber	9,607	19,556	9,607	15	22,953	60,989	22,953	184
			Less than	sawtimber			Less than	sawtimber
Poletimber								
lodgepole pine	2,967	4,439	2,967	.5	14,786	14,765	20,124	66
spruce-fir	440	492	440	4	675	3,611	3,005	30
Douglas-fir	1,477	888	1,477	.4	0	974	0	5
ponderosa pine	N/A	N/A	N/A	N/A	0	450	0	.1
white bark/ limber pine	N/A	N/A	N/A	N/A	0		0	
aspen	N/A	N/A	0	3.4	0	331	0	N/A
Total Poletimber	4,884	5,819	4,884	8.3	15,461	20,131	23,129	102
			Potential yield[4]				Potential	yield[8]
Seedling and Sapling								
lodgepole pine	N/A	N/A	586	385	5,338	2,122	1,809	1,615
spruce-fir	N/A	N/A			2,330	992		
Douglas-fir	N/A	N/A			0	92		
ponderosa pine	N/A	N/A			0	N/A		
white bark/ limber pine								
aspen	N/A	N/A			0	64		
Total seedling & sapling	N/A	N/A			7,668	3,270		
Totals	14,491	25,375			46,082	84,390		

1/ TMP., Shoshone National Forest 1976-1985; p. 23, Part 1.
2/ TMP., Shoshone National Forest 1976-1985; p. 23, Part 3.
3/ Volumes were obtained from 1979 RPA data.
4/ TMP., Shoshone National Forest 1976-1985; p. 1.
5/ TMP., Bighorn National Forest 1975-1985; P. A-22.
6/ TMP., Bighorn National Forest 1975-1985; P.A-11.
7/ Volumes were obtained from 1979 RPA data.
8/ TMP., Bighorn National Forest 1975-1985; p. 2.

Buffalo-Sheridan Procurement Area

The Buffalo-Sheridan Procurement Area contains 65.21 percent of the Bighorn National Forest of which 26.41 percent of the commercial forest land is classified as marginal.

The actual cut is about one-sixth of the potential yield and about half of the programmed cut. The mills are operating at 40 percent of potential output. It seems there is an over capacity given the volumes currently programmed for cut. The possible RARE II setasides are a significant share (83 percent) of the standard and special components. This area, more than any other procurement area, could have a need for timber supplied from the marginal component.

Buffalo-Sheridan Procurement Area

Bighorn National Forest

	Live Timber		Mortality		Live Timber		Mortality		
	Acres[1/]	MCF[2/]	Acres[1/]	MCF[3/]	Acres	MCF	Acres	MCF	
Sawtimber									
lodgepole pine	19,011	50,942	19,011	194					
spruce-fir	22,752	51,373	22,752	127					
Douglas-fir	N/A	11,125	N/A	22					
ponderosa pine	1,262	792	1,262	2					
white bark/ limber pine									
aspen	N/A	86	N/A	N/A					
Total Sawtimber	43,025	114,318	43,025	345					
Poletimber			Less than	sawtimber			Less than	sawtimber	
lodgepole pine	27,716	27,676	37,722	125					
spruce-fir	1,266	6,768	5,634	57					
Douglas-fir	N/A	1,825	N/A	9					
ponderosa pine		844	N/A	1					
white bark/ limber pine									
aspen		620		N/A					
Total Poletimber	28,982	37,733	43,356	192					
Seedling and Sapling			Potential yield[4/]				Potential	yield	
lodgepole pine	10,006	3,978	3,391	3,027					
spruce-fir	4,368	1,860							
Douglas-fir	N/A	172							
ponderosa pine		N/A							
white bark/ limber pine									
aspen		120							
Total seedling & sapling	14,374	6,130							
Totals	36,381	158,181							

1/ TMP., Bighorn National Forest 1975-1985; P. A-22.

2/ TMP., Bighorn National Forest 1975-1985; P. A-11.

3/ TMP., Volumes were obtained from 1979 RPR data.

4/ TMP., Bighorn National Forest 1975-1985; p. 2.

Dubois Procurement Area

The Dubois procurement area contains 35.63 percent of the Shoshone National Forest and 68.02 percent of the Teton National Forest.* The percent of commercial forest land classified marginal is 6.52 percent for the Shoshone and 8.93 for the Teton. This is the smallest proportion of marginal land in any procurement area.

The current actual cut exceeds the programmed allowable cut and is a large share of the potential yield. Under these conditions the mills are operating at less than one-hald of potential capacity. This is a clear indication of mill over capacity.

This area is already using a significant proportion of the standard and special component timber supply. Though RARE II areas do not make up a significant proportion of the area, the mills size and large demand might make it possible to harvest timber within the marginal component. However, it must be noted that only 8.3 percent of this procurement area is classified marginal and cannot be relied upon as a major source. Further, the amount of acreage and volumes of timber involved are not extensive.

*Annual Potential Yield Data is given as 3,134 acres and 51,520 MBF for a combined Bridger-Teton National Forest. The TMP's show the total acreage classified marginal for the two at 171,545 acres; 126,685 or 74% for the Bridger N.F. and 44,860 or 26% is for the Teton N.F. These percentages were applied to the potential yield data to find the potential yield for each forest separately.

Dubois Procurement Area

	Shoshone National Forest				Teton National Forest			
	Live Timber		Mortality		Live Timber		Mortality	
	Acres[1]	MCF[2]	Acres[1]	MCF[3]	Acres[5]	MCF[6]	Acres[5]	MCF[7]
Sawtimber								
lodgepole pine	1,500	3,134	1,500	1	2,924	5,979	2,924	5
spruce-fir	1,756	4,586	1,756	6	12,066	31,854	12,066	-
Douglas-fir	2,061	3,105	2,061	1	12,571	17,627	12,571	-
ponderosa pine	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
white bark/ limber pine	N/A	N/A	N/A.	N/A	N/A	1,679	N/A	
aspen	N/A	N/A	N/A	N/A	N/A	192	N/A	
Total Sawtimber	5,317	10,825	5,317	8	27,567	57,331	27,567	5
Poletimber			Less than	sawtimber			Less than	sawtimber
lodgepole pine	1,643	2,457	1,643	0	1,204	148	1,204	2
spruce-fir	244	272	244	2	480	66	480	-
Douglas-fir	818	491	818	0	1,415	251	1,415	-
ponderosa pine	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
white bark/ limber pine	N/A	N/A	N/A	N/A	N/A	N/A	N/A	1
aspen	N/A	N/A	N/A	2	N/A	N/A	N/A	-
Total Poletimber	2,705	3,220	2,705	4	3,099	465	3,099	3
Seedling and Sapling			Potential	yield[4]			Potential	yield[8]
lodgepole pine	N/A	N/A	324	210	N/A	N/A	554	1,822
spruce-fir	N/A	N/A			N/A	N/A		
Douglas-fir	N/A	N/A			N/A	N/A		
ponderosa pine	N/A	N/A			N/A	N/A		
white bark/ limber pine	N/A	N/A			N/A	N/A		
aspen	N/A	N/A			N/A	N/A		
Total seedling & sapling	N/A	N/A			N/A	N/A		
Totals	8,022	14,045			30,666	57,796		

1/ TMP., Shoshone National Forest 1976-1985; p. 23, part 1.
2/ TMP., Shoshone National Forest 1976-1985; p. 23, part 3.
3/ Volumes were obtained from 1979 RPA data.
4/ TMP., Shoshone National Forest 1976-1985; p. 1.
5/ TMP., Teton National Forest 1962-1979; p. 15.
6/ TMP.M Teton National Forest 1962-1979; p. 15.
7/ Volumes were obtained from 1979 RPA data.
8/ Volumes were obtained from 1979 RPA data.

Pinedale Procurement Area

The Pinedale procurement area contains 60.24 percent of the Bridger National Forest and 13.88 percent of the Teton National Forest. The percent of commercial forest land classified marginal is 27.77 percent for the Bridger and 8.93 for the Teton.

The actual cut exceeds the programmed allowable cut and is a large share of the potential yield. Under these conditions the mills are operating at slightly less than one-half of potential capacity. As in the Dubois case, there is an oversized mill capacity given the raw material capabilities of the procurement area.

This area is already using a significant proportion of the standard and special component timber supply. If the mills were to operate at greater capacity, it would be necessary to harvest timber within the marginal component. If all the RARE II areas (24% of the standard and general components) become classified as wilderness, then the timber supply problem would be intensified even further. However, since only 19.2 percent of this procurement area is classified as marginal,even the full harvesting of the marginal component would probably not meet the entire potential timber needs.

Pinedale Procurement Area

	Bridger National Forest				Teton National Forest			
	Live Timber		Mortality		Live Timber		Mortality	
	Acres[1]	MCF[2]	Acres[1]	MCF[3]	Acres[5]	MCF[6]	Acres[5]	MCF[7]
awtimber								
lodgepole pine	15,551	18,339	15,551	783	597	1,220	597	36
spruce-fir	17,090	45,724	17,090	490	2,462	6,500	2,462	17
Douglas-fir	20,004	21,061	20,004	134	2,566	3,597	2,566	1
ponderosa pine	N/A	N/A	N/A	0	N/A	N/A	N/A	-
white bark/ limber pine	1,436	2,775	1,436	5	1	343	N/A	4
aspen	186	339	186	0	1	39	N/A	
Total Sawtimber	1,622	88,238	1,622	1,412	5,625	11,699	5,625	58
oletimber			Less than	sawtimber			Less than	sawtimber
. lodgepole pine	5,903	737	8,990	129	245	30	245	5
spruce-fir	609		1,202	107	67	13	67	15
Douglas-fir	1,829		2,343	0	288	51	288	-
ponderosa pine	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
white bark/ limber pine	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
aspen	7,136	241	N/A	N/A	N/A	N/A	N/A	
Total Poletimber	15,477	1,852	9,091	236	600	94	600	20
eedling and Sapling			Potential yield[4]				Potential	yield[8]
lodgepole pine	3,087	92	1,397	4,593	N/A	N/A	113	372
spruce-fir	593	N/A			N/A	N/A		
Douglas-fir	514	N/A			N/A	N/A		
ponderosa pine	N/A	N/A			N/A	N/A		
white bark/ limber pine	N/A	N/A			N/A	N/A		
aspen	1,955	N/A			N/A	N/A		
Total seedling & sapling	6,149	92			N/A	N/A		
Totals	23,248	90,182			6,225	11,793		

1/ TMP., Bridger National Forest, 1964-1970; p. 13.
2/ TMP., Bridger National Forest, 1964-1970; p. 13.
3/ Volumes were obtained from 1979 RPA data.
4/ Volumes were obtained from 1979 RPA data.
5/ TMP., Teton National Forest 1962-1971; p. 15.
6/ TMP., Teton National Forest 1962-1971; p. 15.
7/ Volumes were obtained from 1979 RPA data.
8/ Volumes were obtained from 1979 RPA data.

Afton-Freedom-Alpine Procurement Area

The Afton-Freedom Alpine procurement area contains 23.29 percent of the Bridger National Forest, 18.09 percent of the Teton National Forest, and 58.86 percent of the Targhee National Forest. The percent of commercial forest land classified as marginal is 27.77 percent for the Bridger, 8.93 percent for the Teton, and 13.78 percent for the Targhee.

The current actual cut greatly exceeds the programmed allowable cut but is only one-half of the potential yield. This is a result of cutting past sales and salvage harvest in a strong lumber market year. Because the mills are operating at nearly full capacity, a full capacity level of output would probably not exhaust the timber supply in the Standard and Special Component areas under a potential yield management situation. However, since the RARE II areas comprise 50 percent of the area, the classification of all RARE II areas as wilderness could necessitate the timber harvesting of marginal lands. In this case full utilization of the marginal component areas may be sufficient to meet the mill demand for timber.

Afton-Freedom-Alpine Procurement Area

	Teton National Forest				Bridger National Forest			
	Live Timber		Mortality		Live Timber		Mortality	
	Acres[1]	MCF[2]	Acres[1]	MCF[3]	Acres	MCF	Acres	MCF
awtimber								
lodgepole pine	778	8,791	778	68	6,012	7,090	6,012	303
spruce-fir	3,209	8,472	3,209	33	6,607	17,678	6,607	190
Douglas-fir	3,345	4,688	3,345	1	7,734	8,143	7,734	5
ponderosa pine	N/A	N/A	N/A	0	N/A	N/A	N/A	0
white bark/ limber pine	N/A	2,469	N/A	8	555	1,073	555	2
aspen	N/A	282	N/A	0	72	131	72	0
Total Sawtimber	7,332	24,702	7,332	110	20,980	34,115	20,980	500
oletimber			Less than	sawtimber			Less than	sawtimber
lodgepole pine	320	39	320	10	2,282	379	3,475	50
spruce-fir	87	114	87	29	235	204	282	41
Douglas-fir	376	66	376	0	707	134	906	0
ponderosa pine	N/A	N/A	N/A	0	N/A	N/A	N/A	0
white bark/ limber pine	N/A	0	N/A	1	N/A	N/A	N/A	0
aspen	N/A	N/A	N/A	0	2,758	93	3,514	0
Total Poletimber	783	219	783	40	5,982	810	8,177	91
eedling and Sapling			Potential	yield[4]			Potential	yield[4]
lodgepole pine	N/A	N/A	147	485	1,193	36	540	1,776
spruce-fir	N/A	N/A			47	0		
Douglas-fir	N/A	N/A			199	0		
ponderosa pine	N/A	N/A			N/A	0		
white bark/ limber pine	N/A	N/A			N/A	0		
aspen	N/A	N/A			756	36		
Total seedling & sapling	N/A	N/A			2,195	72		
Totals	8,115	24,921			29,157	34,997		

Afton-Freedom-Alpine Procurement Area
Targhee National Forest

	Live Timber		Mortality		Live Timber		Mortality	
	Acres 9/	MCF 10/	Acres 9/	MCF 11/	Acres	MCF	Acres	MCF
Sawtimber								
lodgepole pine	1,315	3,404	1,315	632				
spruce-fir	8,097	36,057	8,097	76				
Douglas-fir	2,586	56,154	2,586	145				
ponderosa pine	N/A	N/A	N/A	0				
white bark/ limber pine	N/A	1,485	N/A					
aspen	92	97	92	2				
Total Sawtimber	12,090	97,197	12,090	855				
Poletimber			Less than	sawtimber			Less than	sawtimber
lodgepole pine	3,391	3,241	4,375	159				
spruce-fir	895	137	1,271	25				
Douglas-fir	5,148	259	5,431	1				
ponderosa pine	N/A	N/A	N/A					
white bark/ limber pine	N/A	3	N/A					
aspen	14,328	564	18,137	11				
Total Poletimber	23,752	4,204	29,214	197,				
Seedling and Sapling			Potential yield 12/				Potential	yield
lodgepole pine	994	N/A	735	713				
spruce-fir	376	N/A						
Douglas-fir	283	N/A						
ponderosa pine	N/A	N/A						
white bark/ limber pine	N/A	N/A						
aspen	3,809	42						
Total seedling & sapling	5,462	42						
Totals	41,304	101,443						

1/ TMP., Teton National Forest, 1962-1971 p. 15.
2/ TMP., Teton National Forest, 1962-1971; p. 15.
3/ Volumes were obtained from 1979 RPA data.
4/ Volumes were obtained from 1979 RPA data.
5/ TMP., Bridger National Forest, 1964-1970; p. 13.
6/ TMP., Bridger National Forest, 1964-1970; p. 13.
7/ Volumes were obtained from 1970 RPA data.
8/ Volumes were obtained from 1979 RPA data.
9/ TMP., Targhee National Forest, 1966-1970; p. 15.
10/ TMP., Targhee National Forest, 1966-1970; p. 15.
11/ Volumes were obtained from 1979 RPA data.
12/ Volumes were obtained from 1979 RPA data.

Evanston Procurement Area

The Evanston procurement area contains 16.43 percent of the Bridger National Forest and 57.58 percent of the Wasatch National Forest. The percent of commercial forest land classified as marginal is 27.77 percent of the Bridger and 11.89 percent of the Wasatch.

The actual cut is 80 percent of the potential yield with the mills operating at 83 percent of full potential capacity. However, the RARE II proportion of the procurement area is 64 percent. If all RARE II areas became classified as wilderness and if present supply levels were to be maintained, it would probably necessitate utilization of the marginal component areas.

Evanston Procurement Area

	Wasatch National Forest				Bridger National Forest			
	Live Timber		Mortality		Live Timber		Mortality	
	Acres[1]	MCF[2]	Acres[1]	MCF[3]	Acres[5]	MCF[6]	Acres[5]	MCF[7]
Sawtimber								
lodgepole pine	5,414	8,090	5,414	87	4,249	5,011	4,249	214
spruce-fir	4,682	7,790	4,682	14	4,669	12,494	4,669	134
Douglas-fir	5,518	4,543	5,518	0	5,466	5,754	5,466	4
ponderosa pine	24	17	24	0	N/A	N/A	N/A	0
white bark/ limber pine	181	325	181	0	392	758	392	1
aspen	82	311	82	12	51	93	51	0
Total Sawtimber	15,901	21,076	15,901	113	14,827	24,110	14,827	353
Poletimber			Less than	sawtimber			Less than	sawtimber
lodgepole pine	4,565	1,382	4,747	11	1,613	1,338	2,456	35
spruce-fir	632	322	648	9	166	144	328	29
Douglas-fir	663	114	663	0	500	473	640	0
ponderosa pine	0	0	0	0	N/A	N/A	N/A	0
white bark/ limber pine	1	0	1	0	N/A	N/A	N/A	0
aspen	2,061	450	2,146	4	1,949	N/A	2,483	0
Total Poletimber	7,922	2,268	8,215	24	4,228	1,955	5,907	64
Seedling and Sapling			Potential yield[4]				Potential	yield[8]
lodgepole pine	192	1	2,259	2,227	843	25	381	1,252
spruce-fir	16	1			162	N/A		
Douglas-fir	0	0			140	N/A		
ponderosa pine	0	0			N/A	N/A		
white bark/ limber pine	0	0			N/A	N/A		
aspen	85	0			534	66		
Total seedling & sapling	293	2			1,679	91		
Totals	24,116	23,346			20,734	26,156		

1/ TMP., Wasatch National Forest, 1961-1970; p. 15.
2/ TMP., Wasatch National Forest, 1961-1970; p. 15.
3/ Volumes were obtained from 1979 RPA data.
4/ Volumes were obtained from 1979 RPA data.
5/ TMP., Bridger National Forest, 1964-1970; p. 13.
6/ TMP., Bridger National Forest, 1964-1970; p. 13.
7/ Volumes were obtained from 1979 RPA data.
8/ Volumes were obtained from 1979 RPA data.

II. Southern Colorado Marketing Analysis

Introduction

This analysis of production and marketing alternatives for utilizating sawtimber in southwestern Colorado identifies alternatives that are technically and economically feasible given various conditions concerning raw material supply, mill capacities, and market demands. The spruce-fir and ponderosa timber types make up the raw material supply base for the southwestern Colorado area and comprise 80 percent of the sawtimber volume in this area.

The approach and methodology used for this analysis were developed and presented in the Rocky Mountain and Range Experiment Station study #4251-21 entitled, Production and Marketing Alternatives for Utilizing Lodgepole Pine in Colorado and Wyoming. A major portion of the information required for this analysis was available from two previous studies, RM 4251-18 and RM 4251-21. In those studies the southwestern area of Colorado was defined as the "Southern Colorado Cluster" including three procurement areas--Monte Vista-South Fork, Durango-Dolores, and Pagosa Springs--with Durango as the marketing center. Data presented in the two previous studies included ponderosa pine and spruce-fir sawtimber volumes, stumpage, procurement, and milling costs, and product values.

Using the same analytical procedure, values for ponderosa pine were substituted in this study where data for lodgepole pine (the primary species analyzed in RM 4251-21) had been used previously. Figures for stumpage, procurement, and transportation costs were derived from existing secondary data. Procurement costs were calculated from the same timber sales appraisal sheets used in RM 4251-18. Costs for ponderosa pine were prorated according to sales volume and then averaged for each procurement area. The costs for the three procurement areas were added together and averaged, yielding the average procurement cost used for the market cluster. The stumpage cost used for deriving total production costs was the average of the lowest costs of stumpage reported from each processing center within the cluster.

costs were calculated by adjusting the lodgepole pine values using the difference in shipping weight between lodgepole pine and ponderosa pine:

Weight of timber species: Lodgepole pine = 28,650 lbs/MCF

Ponderosa pine = 28,000 lbs/MCF

Adjustment factor = 28,000/28,650 = .9773.

The linear program model used in RM 4251-21 was modified to fit the Southern Colorado Cluster situation. All variables using the "LP" abbreviation for lodgepole pine were changed to "PP" signifying ponderosa pine. All coefficients of the objective function relating to lodgepole pine were changed to reflect the residual values for ponderosa pine. Three rows in the program pertaining to production constraints for fenceposts, pallets, and utility poles were eliminated since these products were not produced in the Southern Colorado Cluster.

Market Area Evaluation and Analysis

Areas in the United States where Colorado mills currently market their products are illustrated in Figure II-1. Most mills do not cover this entire area, but instead have customers in select locations who purchase their products. Within this general marketing area, Standard Metropolitan Statistical Areas (SMSA's) were grouped together to form "SMSA zones."

Although certain zones are large consumers of wood products, it does not mean that Colorado mills could be competitive in such markets. In some cases transportation-to-market costs may be too large given the wholesale lumber prices in the area. To determine in which zones Colorado mills could be competitive a marginal analysis was performed utilizing the costs of all the mill and marketing operations and wholesale product prices at the market destination. The marginal analysis utilizes all production cost factors and wholesale product returns in a single equation. Solving the equation allows estimation of the products' profitability when distributed from a mill to a specific SMSA zone. The following formula was used:

$$MR - MC - (P\&R) = Z$$

Where:

MR (marginal revenue) = wholesale price (1977) per MCF of product at point of sale.

MC (marginal cost) = summation of stumpage, procurement, milling, handling, and transportation cost-to-market per MCF of product.

P&R (profit and risk) = 11 percent of total marginal cost per MCF of product.

Z (residual value)[3/] = dollar value per MCF of product remaining (all costs and prices assumed constant and do not change with volume).

This equation was applied to each product line. Where the residual value (Z) was found to be positive, it was concluded that the particular product may be marketed economically in the respective market area. If the residual value was found to be negative, the opposite conclusion applied. The larger the residual value, the more competitive and profitable the product. Therefore the best markets for Colorado mills were where the residuals, the difference between costs and prices, were highest. Using this procedure certain products were found unprofitable for certain SMSA zones and some high consumption SMSA zones were deleted completely from the analysis. Some of those considered but deleted were near major local softwood lumber production centers which could make major contributions to the local demand. This is the situation in the Arkansas-Oklahoma-Texas area which

3/ Economists would refer to this residual value as locational rent.

is largely dominated by Southern manufacturers and the Southwestern and Intermountain areas of the U.S. which also have large local production capacity.

The final marketing analysis involved the investigation of potential markets within Colorado and Wyoming arising from increased energy development activities, especially coal, in Colorado and Wyoming. The direct impacts analyzed relate primarily to wood use in the form of mine timbers and props, as coal companies expand underground mining over the next ten to twelve years. The indirect impacts considered concern the expected increase in housing as energy and mineral developments affect the local areas involved.

Table II-1 Cost Breakdown for the Southern Colorado Cluster

stumpage	- Represents the average of lowest costs of stumpage in Southern Colorado Cluster. When the average value was found to be negative, the stumpage base rate established on USFS timber sales appraisal summaries was used to represent the lowest stumpage value.
procurement	- Represents costs of harvesting, clean-up, roads, and haul to the mill. The cost shown is the average of the costs of procurement per MBF of species in the Southern Colorado Cluster. All USFS timber sale appraisal summaries obtained for all four processing areas within the cluster served as a basis for this determination.
P&R	- Refers to profit and risk established at 11% of marginal revenue, an average reported as desirable by all mills consulted and considered appropriate by the USFS to represent allowable profit margin on timber sale appraisals.
milling	- Costs for the manufacture of each product from the point of receipt of raw material at the mill. The cost for each product was determined from information supplied from all mills contacted in Colorado and represents an average cost for each product.
transportation	- Cost of delivering MCF of product to the extreme edge of the given market zone. Transportation costs are based on freight costs per hundred weight per loaded truck (40,000 lbs.)[2/]
product value	- Refers to an average wholesale value as determined for a product in a given market zone[3/].

1/ Stumpage, procurement, and milling cost for FY 1977.

2/ Transportation rates as of March, 1978.

3/ Current product values as of March, 1978.
New product values as of February, 1979.

Table II-1A Cost Breakdown for the Southern Colorado Cluster.

Products (ponderosa pine)	Stumpage (Log Scale) MBF	Stumpage (Final Product) MCF	Stumpage (Final Product) MCF	Procurement (Log Scale) MBF	Procurement (Final Product) MCF	Procurement (Final Product) MCF	Milling (Final Product) MBF	Milling (Final Product) MCF	Profit and Risk (% of MR)	Transportation to 80 miles MCF	Transportation to 300 miles MCF	Transportation to 600 miles MCF
Dimension	10.12	50.60	150.16	72.36	361.80	1073.24	132.30	2334.10	11	81.20	176.40	324.80
Planed Boards	10.12	50.60	167.23	72.36	361.80	1195.91	110.00	1999.80	11	81.20	176.40	324.80
Rough Boards	10.12	50.60	139.15	72.36	361.80	995.28	74.10	1121.13	11	81.20	176.40	324.80
Houselogs	10.12	50.60	50.60	72.36	361.80	361.80	N/A	1184.30	11	81.20	176.40	324.80
Studs	10.12	50.60	155.60	72.36	361.80	1112.16	100.00	1829.00	11	81.20	176.40	324.80
Pallets	10.12	50.60	136.62	72.36	361.80	977.30	90.00	1374.30	11	81.20	176.40	324.80
Timbers	10.12	50.60	101.07	72.36	361.80	723.09	185.00	2643.65	11	81.20	176.40	324.80
Fence Posts	10.12	50.60	58.84	72.36	361.80	420.70	N/A	1728.00	11	81.20	176.40	324.80
Joists (green)	10.12	50.60	158.83	72.36	361.80	1135.65	40.00	678.00	11	81.20	176.40	324.80
(dead)[1/]	10.12	50.60	295.75	72.36	361.80	2144.66	60.00	1017.00	11	81.20	176.40	324.80
Railroad Ties	10.12	50.60	84.92	72.36	361.80	607.22	76.19	914.34	11	81.20	176.40	324.80
Utility Poles	10.12	50.60	53.83	72.36	361.80	384.80	N/A	1213.25	11	81.20	176.40	324.80
Fencing	10.12	50.60	46.00	72.36	361.80	328.91	N/A	4411.80	11	81.20	176.40	324.80
Paneling	10.12	50.60	749.34	72.36	361.80	1071.59	N/A	5600.00	11	81.20	176.40	324.80
Firewood	.50	2.50	2.50	70.45	352.25	352.25	N/A	235.20	11	81.20	176.40	324.80
Structural Flakeboard[2/]	1.00	5.00	5.38	81.61	408.65	438.65	N/A	1173.24	11	87.38	167.67	250.33

1/ 50% recovery

2/ Values are based on a structural flakeboard feasibility study for Laramie, Wyoming, by Don Markstrom of the Rocky Mountain Forest and Range Experiment Station. Stumpage and procurement costs are for chips from forest residues. For all other products in this study, the stumpage and procurement costs are in terms of volume of final product to be produced, but for structural flakeboard they represent the volume of chips as if chips were the final product and not flakeboard. Procurement process from the woods to the sawmill, to the flakeboard plant. Milling costs include gluing and waxing costs. This also assumes that chips are the sole wood component for flakeboard along with glue and wax.

Table II-1A (continued)

Transportation to 1000 miles MCF	Transportation to 1300 miles MCF	Handling MCF	Product Value to 80 miles MBF	Product Value to 80 miles MCF	Product Value to 300 miles MBF	Product Value to 300 miles MCF	Product Value to 600 miles MBF	Product Value to 600 miles MCF	Product Value to 1000 miles MBF	Product Value to 1000 miles MCF	Product Value to 1300 miles MBF	Product Value to 1300 miles MCF
425.60	509.60	35.00	245.00	4324.25	245.00	4324.25	265.00	4677.25	270.00	4765.50	260.00	4589.00
425.60	509.60	35.00	370.00	6726.60	385.00	6999.30	395.00	7181.10	385.00	6999.30	475.00	8635.00
425.60	509.60	35.00	180.00	2723.40	205.00	3101.65	200.00	3026.00	185.00	2799.05	190.00	2874.70
425.60	509.60	35.00	N/A	2674.22	N/A	2674.22	N/A	2674.00	N/A	2674.22	N/A	2674.22
425.60	509.60	35.00	260.00	4755.40	260.00	4755.40	270.00	4938.30	300.00	5487.00	300.00	5487.00
425.60	509.60	35.00	327.75	5004.74	327.75	5004.74	327.75	5004.74	327.75	5004.74	327.75	5004.74
425.60	509.60	35.00	400.00	5716.00	400.00	5716.00	420.00	6001.80	425.00	6073.25	425.00	6073.25
425.60	509.60	35.00	N/A	3456.00	N/A	3456.00	N/A	3456.00	N/A	3456.00	N/A	3456.00
425.60	509.60	35.00	310.00	5254.50	335.00	5678.25	330.00	5593.00	350.00	5932.50	350.00	5932.00
425.60	509.60	35.00	310.00	5254.50	335.00	5678.25	330.00	5593.50	350.00	5932.50	350.00	5932.00
425.60	509.60	35.00	190.50	2285.84	190.50	2285.84	190.50	2285.84	190.50	2285.84	190.50	2285.84
425.60	509.60	35.00	N/A	3952.24	N/A	3952.24	N/A	3952.24	N/A	3952.24	N/A	3952.24
425.60	509.60	35.00	N/A	6691.23	N/A	6691.23	N/A	6691.23	N/A	6691.23	N/A	6691.23
425.60	509.60	35.00	N/A	9600.00	N/A	9600.00	N/A	9600.00	N/A	9600.00	N/A	9600.00
425.60	509.60	35.00	N/A	788.13	N/A	871.43	N/A	1001.28	N/A	1089.48	N/A	1162.98
401.47	512.47	35.00	N/A	1440.00	N/A	1560.00	N/A	1680.00	N/A	1680.00	N/A	1680.00

Table II-1B Cost Breakdown for the Southern Colorado Cluster

Products (spruce-fir)	Stumpage (log Scale) MBF	Stumpage (log Scale) MCF	Stumpage (Final Product) MCF	Procurement (Log Scale) MBF	Procurement (Log Scale) MCF	Procurement (Final Product) MCF	Milling (Final Product) MBF	Milling (Final Product) MCF	Profit and Risk (% of MR)	Transportation to 80 miles MCF	Transportation to 300 miles MCF	Transportation to 600 miles MCF
Dimension	.80	4.00	11.87	62.55	312.75	927.74	132.30	2335.10	11	71.05	154.35	284.20
Planed Boards	.80	4.00	13.22	62.55	312.75	1033.78	110.00	1999.80	11	71.05	154.35	284.20
Rough Boards	.80	4.00	11.00	62.55	312.75	860.35	74.10	1121.13	11	71.05	154.35	284.20
Houselogs	.80	4.00	4.00	62.55	312.75	312.67	N/A	1184.30	11	71.05	154.35	284.20
Studs	.80	4.00	12.30	62.55	312.75	961.38	100.00	1829.00	11	71.05	154.35	284.20
Pallets	.80	4.00	10.80	62.55	312.75	844.81	90.00	1374.30	11	71.05	154.35	284.20
Timbers	.80	4.00	7.99	62.55	312.75	625.06	185.00	2643.65	11	71.05	154.35	284.20
Fence Posts	.80	4.00	4.65	62.55	312.75	363.66	N/A	1728.00	11	71.05	154.35	282.20
Joists(green)	.80	4.00	12.56	62.55	312.75	981.69	40.00	678.00	11	71.05	154.35	284.20
(dead)[1/]	.80	4.00	23.38	62.55	312.75	1827.97	60.00	1017.00	11	71.05	154.35	284.20
Railroad Ties	.80	4.00	6.71	62.55	312.75	524.90	76.19	914.34	11	71.05	154.35	284.20
Utility Poles	.80	4.00	4.26	62.55	312.75	332.71	N/A	1213.25	11	71.05	154.35	284.20
Fencing	.80	4.00	3.64	62.55	312.75	284.32	N/A	4411.80	11	71.05	154.35	284.20
Paneling	.80	4.00	59.24	62.55	312.75	926.31	N/A	5600.00	11	71.05	154.35	284.20
Firewood	.50	2.50	2.50	70.45	352.25	352.25	N/A	235.20	11	71.05	154.35	284.20
Structural flakeboard[2/]	1.00	5.00	5.38	81.61	408.05	438.65	N/A	1173.24	11	87.38	167.67	250.33

1/ 50% recovery.

2/ Values are based on a structural flakeboard feasibility study for Laramie, Wyoming, by Don Markstrom of the Rocky Mountain Forest and Range Experiment Station. Stumpage and procurement costs are for chips from forest residues. For all other products in this study, the stumpage and procurement costs are in terms of volume of final product to be produced, but for structural flakeboard they represent the volume of chips as if chips were the final product and not flakeboard. Procurement costs cover the total procurement process from the woods to the sawmill, to the flakeboard plant. Milling costs include gluing and waxing costs. This also assumes that chips are the sole wood component for flakeboard along with glue and wax.

Table II-1B (continued)

Transportation to 1000 miles MCF	Transportation to 1300 miles MCF	Handling MCF	Product Value to 80 miles MBF	Product Value to 80 miles MCF	Product Value to 300 miles MBF	Product Value to 300 miles MCF	Product Value to 600 miles MBF	Product Value to 600 miles MCF	Product Value to 1000 miles MBF	Product Value to 1000 miles MCF	Product Value to 1300 miles MBF	Product Value to 1300 miles MCF
372.40	445.90	35.00	245.00	4324.25	245.00	4324.25	265.00	4677.25	270.00	4765.00	260.00	4589.00
372.40	445.90	35.00	370.00	6726.60	385.00	6999.30	395.00	7181.10	385.00	6999.30	475.00	8635.00
372.40	445.90	35.00	180.00	2723.40	205.00	3101.65	200.00	3026.00	185.00	2799.05	190.00	2874.70
372.40	445.90	35.00	N/A	2674.22	N/A	2674.22	N/A	2674.22	N/A	2674.22	N/A	2674.22
372.40	445.90	35.00	260.00	4755.40	260.00	4755.40	270.00	4938.00	300.00	5487.00	300.00	5487.00
372.40	445.90	35.00	327.75	5004.74	327.75	5004.74	327.75	5004.75	327.75	5004.74	327.75	5004.74
372.40	445.90	35.00	400.00	5716.00	400.00	5716.00	420.00	6001.80	425.00	6073.25	425.00	6073.25
372.40	445.90	35.00	N/A	3456.00	N/A	3456.00	N/A	3456.00	N/A	3456.00	N/A	3456.00
372.40	445.90	35.00	310.00	5254.56	335.00	5678.25	330.00	5593.50	350.00	5932.50	340.00	5763.00
372.40	445.90	35.00	310.00	5254.50	335.00	5678.25	330.00	5593.50	350.00	5932.50	340.00	5763.00
372.40	445.90	35.00	190.50	2285.84	190.50	2285.84	190.50	2285.84	190.50	2285.84	190.50	2285.84
372.40	445.90	35.00	N/A	3952.24	N/A	3952.24	N/A	3952.24	N/A	3952.24	N/A	3952.24
372.40	445.90	35.00	N/A	6691.23	N/A	6691.23	N/A	6691.23	N/A	6691.23	N/A	6691.23
372.40	445.90	35.00	N/A	9600.00	N/A	9600.00	N/A	9600.00	N/A	9600.00	N/A	9600.00
372.40	445.90	35.00	N/A	788.13	N/A	871.43	N/A	1001.28	N/A	1089.48	N/A	1162.98
491.47	512.47	35.00	N/A	1440.00	N/A	1560.00	N/A	1680.00	N/A	1680.00	N/A	1680.00

Table II-2A Mill Marginal Analysis

Product (ponderosa pine)	MR/MCF	MC/MCF	P&R/MCF	Z/MCF
	Market to 80 miles			
Dimension	$4324.25	3674.70	404.14	245.41
Planed Boards	6726.60	3479.14	382.69	2864.77
Rough Boards	2723.40	2371.76	260.81	90.83
Houselogs	2674.22	1712.90	188.32	773.00
Studs	4755.40	3212.94	353.32	1189.14
Pallets	5004.74	2604.42	286.43	2113.90
Timbers	5716.00	3584.01	394.24	1737.75
Fence Posts	3456.00	2208.24	242.88	1004.88
Joists(green)	5254.50	2088.68	229.68	2936.14
(dead)	5254.50	3543.61	389.73	1321.76
Railroad Ties	2285.84	1722.68	180.42	373.74
Utility Poles	3952.24	1768.17	194.48	1989.59
Paneling	9600.00	7537.13	829.07	1233.80
Fencing	6691.23	4904.91	539.44	1246.88
Firewood	788.13	705.97	77.55	4.61
Structural Flakeboard	1440.00	1739.65	191.36	-491.01
	Market to 300 miles			
Dimension	4324.00	3769.90	414.69	139.66
Planed Boards	6999.30	3574.34	393.18	3031.78
Rough Boards	3101.65	2466.96	271.37	363.02
Houselogs	2674.22	1808.10	198.89	667.23
Studs	4755.40	3408.14	374.90	1083.36
Pallets	5004.74	2699.62	296.96	2008.16
Timbers	5716.00	3679.21	404.71	1632.08
Fence posts	3456.00	2303.44	253.38	899.18
Joists(green)	5678.25	2183.88	240.23	3254.14
(dead)	5678.25	3638.81	400.27	1639.17
Railwoad Ties	2285.84	1817.88	199.97	267.99
Utility Poles	3952.24	1863.37	204.97	1884.00
Paneling	9600.00	7632.33	839.56	1128.11
Fencing	6691.23	4998.11	549.79	1143.33
Firewood	871.43	801.17	88.13	-17.13
Structural Flakeboard	1560.00	1819.94	200.19	-460.13

Table II-2A (continued)

Product (ponderosa pine)	MR/MCF	MC/MCF	P&R/MCF	Z/MCF
	Market to 600 miles			
Dimension	$4677.25	3918.30	431.01	327.94
Planed Boards	7181.10	3722.74	409.50	3048.86
Rough Boards	3026.00	2615.36	287.60	122.95
Houselogs	2674.22	1956.50	215.22	502.50
Studs	4938.30	3456.59	380.22	1101.54
Pallets	5004.74	2848.02	313.28	1843.44
Timbers	6001.80	3827.61	421.04	1753.15
Fence Posts	3456.00	2451.84	269.70	734.46
Joists(green)	5593.50	2332.28	256.55	3004.67
(dead)	5593.50	3787.21	416.54	1389.70
Railroad Ties	2285.84	1966.28	216.29	103.27
Utility Poles	3952.24	2011.77	221.29	1719.18
Fencing	6691.23	5146.51	855.80	978.60
Paneling	9600.00	7780.73	566.12	963.39
Firewood	1001.28	949.57	104.45	-52.74
Structural Flakeboard	1680.00	1902.60	209.29	-431.89
	Market to 1000 miles			
Dimension	4765.50	4019.10	442.10	304.30
Planed Boards	6999.30	3823.54	420.59	2755.17
Rough Boards	2799.05	2716.16	298.78	-215.89
Houselogs	2674.22	2057.30	226.30	390.62
Studs	5487.00	3557.34	391.31	1538.35
Pallets	5004.74	2948.82	324.37	1731.55
Timbers	6073.25	3928.41	432.13	1712.71
Fence Posts	3456.00	2552.64	280.79	622.57
Joists(green)	5932.50	2433.08	267.64	3231.78
(dead)	5932.50	3588.01	394.68	1949.81
Railroad Ties	2285.84	2067.08	227.38	-8.62
Utility Poles	3952.24	2112.57	232.38	1607.29
Fencing	6691.23	5247.31	577.20	866.72
Paneling	9600.00	7881.53	866.97	851.50
Firewood	1089.48	1050.37	115.54	-76.43
Structural Flakeboard	1680.00	2053.74	225.91	-599.65

Table II-2A (continued)

Product (ponderosa pine)	Market to 1300 miles MR/MCF	MC/MCF	P&R/MCF	Z/MCF
Dimension	$4589.00	4103.10	451.34	34.56
Planed Boards	8635.00	3907.54	429.83	4298.13
Rough Boards	2874.70	2865.16	425.16	-415.63
Houselogs	2674.22	2141.30	235.54	297.38
Studs	5487.00	3641.34	400.55	1445.11
Pallets	5004.74	3032.82	333.62	1638.31
Timbers	6073.25	4012.41	441.37	1619.47
Fence Posts	3456.00	2636.64	290.03	529.33
Joists(green)	5932.50	2517.08	276.88	3138.50
(dead)	5932.50	3972.01	436.92	1523.57
Railroad Ties	2285.84	2151.08	236.62	-101.86
Utility Poles	3952.24	2196.57	241.62	1514.05
Fencing	6691.23	5331.31	586.44	773.48
Paneling	9600.00	7965.53	876.21	758.26
Firewood	1162.98	1134.37	124.78	-96.17
Structural Flakeboard	1680.00	2164.74	238.12	-722.86

Table II-2B Mill Marginal Analysis

Product (spruce-fir)	MR/MCF	MC/MCF	P&R/MCF	Z/MCF
	Market to 80 miles			
Dimension	$4324.25	3380.79	371.80	571.66
Planed Boards	6726.60	3152.85	346.72	3227.03
Rough Boards	2723.40	2098.53	230.78	394.09
Houselogs	2674.22	1607.02	176.77	890.43
Studs	4755.40	2908.73	319.88	1526.79
Pallets	5004.74	2335.96	256.85	2411.93
Timbers	5716.00	3382.75	372.00	1961.23
Fence Posts	3456.00	2088.86	229.68	1137.46
Joists(green)	5254.50	1778.30	195.58	3280.62
(dead)	5254.50	2974.40	327.14	1952.96
Railroad Ties	2285.84	1552.00	170.72	563.12
Utility Poles	3952.24	1656.27	182.16	2113.81
Fencing	6691.23	4783.81	526.13	1381.29
Paneling	9600.00	6691.60	736.01	2172.99
Firewood	788.13	695.82	76.45	15.86
Structural Flakeboard	1440.00	1739.65	191.36	-491.01
	Market to 300 miles			
Dimension	4324.25	3464.09	381.05	479.11
Planed Boards	6990.30	3236.15	355.98	3407.17
Rough Boards	3101.65	2181.83	240.00	679.82
Houselogs	2674.22	1690.32	185.94	797.98
Studs	4755.40	2992.03	329.12	1434.25
Pallets	5004.74	2419.26	266.12	2319.36
Timbers	5716.00	3466.05	381.27	1868.68
Fence Post	3456.00	2172.16	238.94	1044.90
Joists(green)	5678.25	1861.60	204.78	3611.89
(dead)	5678.25	3057.70	336.35	2284.20
Railroad Ties	2285.84	1635.33	179.89	470.63
Utility Poles	3952.24	1739.57	191.35	2021.32
Fencing	6691.23	4867.11	535.38	2079.86
Paneling	9600.00	6774.90	745.24	1288.74
Firewood	871.43	779.12	85.70	6.61
Structural Flakeboard	1560.00	1819.94	200.19	-460.13

Table II-2B (continued)

Product (spruce-fir)	MR/MCF	MC/MCF	P&R/MCF	Z/MCF
	Market to 600 miles			
Dimension	4677.25	3593.94	395.33	687.98
Planed Boards	7181.10	3366.00	370.26	3444.84
Rough Boards	3026.00	2311.68	254.28	460.04
Houselogs	2674.22	1820.17	200.22	653.83
Studs	4938.30	3121.88	343.41	1473.01
Pallets	5004.74	2549.11	280.40	2175.23
Timbers	6001.80	3595.90	395.55	2010.35
Fence Posts	3456.00	2302.01	253.22	900.77
Joists(green)	5593.50	1991.45	219.06	3382.99
(dead)	5593.50	3187.55	350.63	2055.32
Railroad Ties	2285.84	1765.15	194.17	326.52
Utility Poles	3952.24	1869.40	205.63	1877.21
Fencing	6691.23	4996.96	549.67	1935.73
Paneling	9600.00	6904.75	759.52	1144.60
Firewood	1001.28	908.97	99.99	-7.68
Structural Flakeboard	1680.00	1902.60	209.29	-431.89
	Market to 1000 miles			
Dimension	4765.50	3682.14	405.04	678.32
Planed Boards	6999.30	3454.20	379.96	3165.14
Rough Boards	2799.05	2399.88	263.99	135.18
Houselogs	2674.22	1908.37	209.92	555.93
Studs	5487.00	3210.08	353.11	1923.81
Pallets	5004.74	2637.31	290.10	2077.33
Timbers	6073.25	3684.10	405.25	2019.90
Fence Posts	3456.00	2390.21	262.92	802.87
Joists(green)	5932.50	2079.65	228.76	3624.09
(dead)	5932.50	3275.75	360.33	2296.42
Railroad Ties	2285.84	1853.35	203.87	228.62
Utility Poles	3952.24	1957.62	215.34	1779.28
Fencing	6691.23	5085.16	559.37	1046.70
Paneling	9600.00	6992.95	769.22	1837.83
Firewood	1089.48	997.17	109.69	-17.38
Structural Flakeboard	1680.00	2053.74	225.91	-599.65

Table II-2B (continued)

Market to 1300 miles

Product (spruce-fir)	MR/MCF	MC/MCF	P&R/MCF	Z/MCF
Dimension	4589.00	3755.64	413.12	420.24
Planed Boards	8635.00	3527.70	388.05	4719.75
Rough Boards	2874.70	2473.38	272.07	129.25
Houselogs	2674.22	1981.87	218.01	474.35
Studs	5487.00	3283.58	361.19	1842.23
Pallets	5004.74	2710.81	298.19	1995.74
Timbers	6073.25	3757.60	413.34	1902.31
Fence Posts	3456.00	2463.71	271.01	721.28
Joists(green)	5932.50	2153.15	236.85	3542.50
(dead)	5932.50	3349.25	368.42	2214.83
Railroad Ties	2285.84	1926.85	211.95	147.04
Utility Poles	3952.24	2031.12	223.42	1697.70
Fencing	6691.23	5158.66	567.45	965.12
Paneling	9600.00	7066.45	777.31	1756.24
Firewood	1162.98	1070.67	117.77	-25.46
Structural Flakeboard	1680.00	2164.74	238.12	-722.86

Table II-3. Transportation Costs (Motor Freight) to SMSA-zone Market/Lumber Consumption[1/]

SMSA-zone	Zone City	Distance	Transport Cost/MCF		Consumption[2/]
A. Illinois	Chicago	1311	SF-$481	PP-$543	578,226.1
B. Ohio	Columbus	1484	569	645	399,729.7
C. Michigan	Detroit	1561	599	629	342,865.7
D. E.Texas	Dallas	845	383	432	351,340.6
E. Colorado	Denver	338	209	233	315,215.4
F. Arizona	Phoenix	456	285	320	384,419.1
G. Indiana	Indianapolis	1313	481	543	228,402.2
H. Kentucky-Tennessee	Nashville	1359	501	566	206,183.0
I. Minnesota-Wisconsin	Minneapolis	1162	452	510	259,850.2
J. Wisconsin	Madison	1270	481	543	143,689.6
K. Kansas-Missouri	Kansas City	828	383	432	167,197.3
L. Oklahoma	Oklahoma City	928	398	449	141,656.0
M. Utah	Salt Lake City	397	231	258	176,157.2
N. Iowa	Des Moines	984	407	459	110,218.1
O. W.Texas	Lubbock	524	307	345	101,688.0
P. Arkansas	Little Rock	1061	422	477	46,007.9
Q. New Mexico	Albuquerque	212	148	163	64,007.9
R. Idaho	Boise	770	368	415	37,055.3
S. Montana	Billings	840	383	432	17,796.0

[1/] Costs based on distance from cluster city to representative city in SMSA-zone. Durango, Colorado is the origination point for this cluster.

[2/] Consumption level based on 1977 housing unit permits for SMSAs within the SMSA-zones listed.

Figure II-1 Cluster Center to SMSA-zones / Map 1

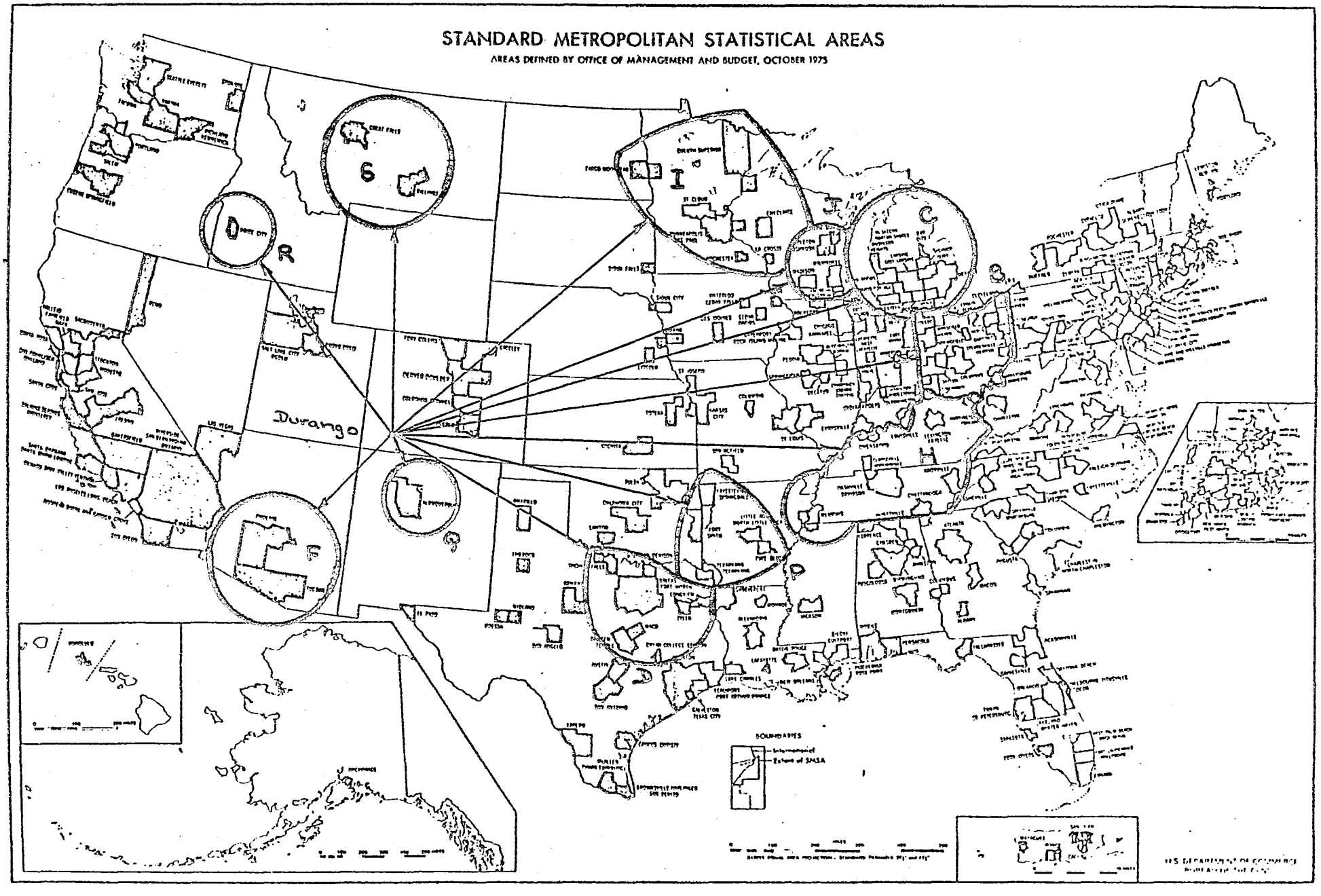
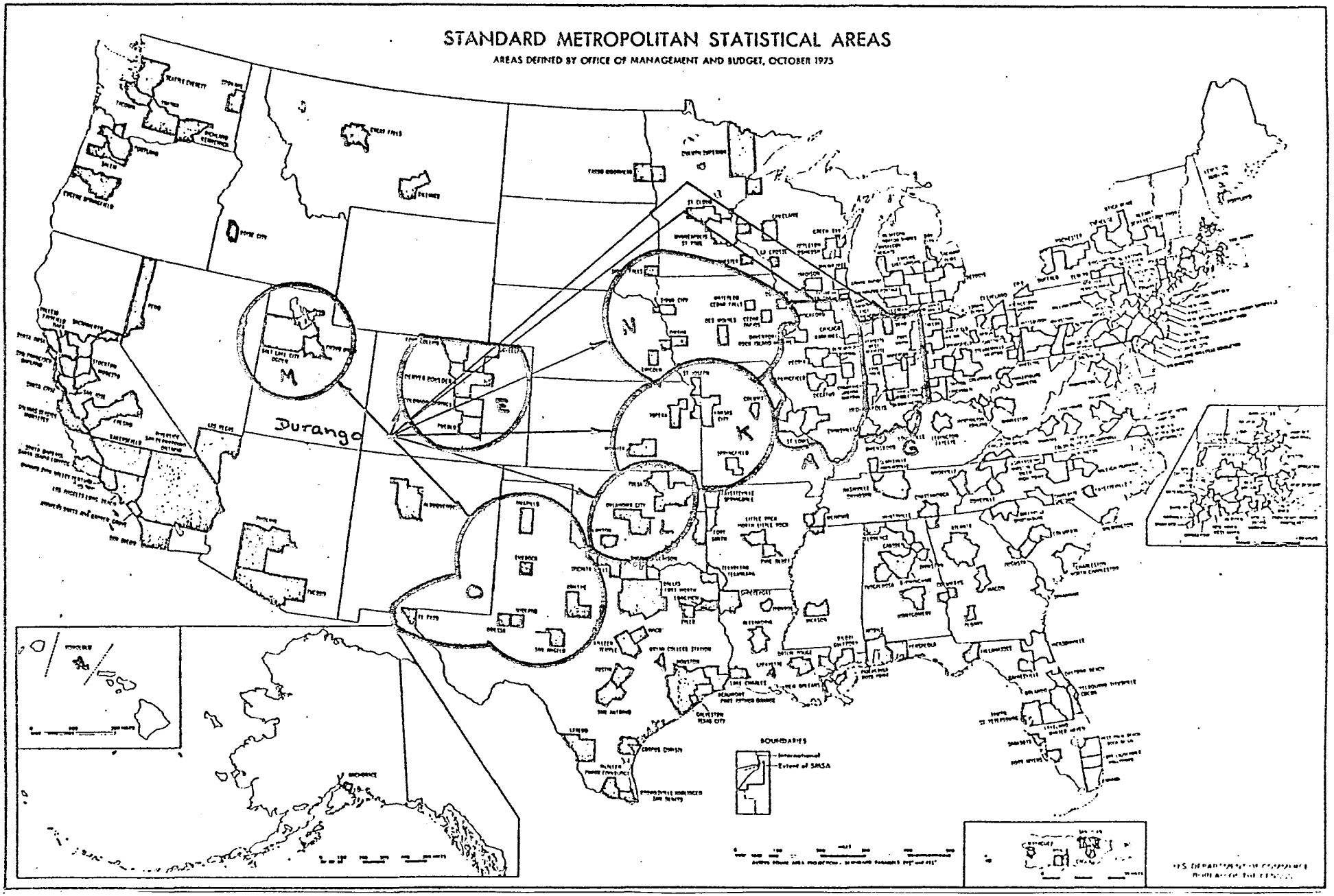


Figure II-1 Cluste[redacted]ter to SMSA-zones / Map 2



Introduction to the Linear Programming Analysis

Alternative production and marketing strategies were developed through the use of a linear programming approach. The Functional Mathematical Programming System (FMPS) available at the USDA Computer Center in Fort Collins was the computer program utilized. The model depicts the inherent characteristics of LP such as deterministic coefficients and constant returns to scale.

Variables

X_{ikjl}.

- i - products produced in each market cluster (14 maximum)
- j - species utilized (raw material) (2 types: ponderosa pine and spruce-fir)
- k - market distances from market cluster (5); based on actual road mileage distances
- l - raw material resource grades (3); ranges from high-valued raw material to deadwood available for mills

i) products

- Planed Boards
- Rough Boards
- Dimension Lumber
- Studs
- Timbers
- Houselogs
- Joists
- Railroad Ties
- Fencing
- Paneling
- Firewood

j) species utilized as raw material resource

- Ponderosa Pine
- Spruce-Fir

k) market distance
   1. 0-80 miles
   2. 81-300 miles
   3. 301-600 miles
   4. 601-1000 miles
   5. 1001-1300 miles

l) Green #1 (High-Valued Resource)
   Green #2 (Moderate-Value Resource)
   Dead (Deadwood Resource)

The eleven products analyzed in this linear programming model are those the mills currently produce or are technically capable of producing with their present equipment, without any major changes in their individual production lines or sawmill operations. Cost data were based on sawtimber size material (excluded poletimber) and were therefore conservative.

Ponderosa pine and spruce-fir are the only two timber types assumed to be available for the mills for wood product production. These two timber types make up approximately 80% of the raw material resource available for sawtimber production. Almost all mills contacted stated that these two types were used almost exclusively. Additional major species which make up the rest of the resource base, but which are not included in this analysis include: Douglas-fir, lodgepole pine and aspen. Aspen is not considered a commercial sawtimber resource at present by the Forest Service and most mills are not utilizing this resource to any great extent at present. Douglas-fir and lodgepole pine make up a rather small part of the raw material base in the market cluster addressed in this study.

The five market distances utilized in this analysis include those areas where mills in Colorado can economically (positive residual values) market their products. Within the five market distances, key market areas, where Colorado lumber producers are most effective in their product sales, are analyzed in the linear program model to determine the optimal marketing sites for the various products. These market areas are typically Standard Metropolitan Statistical Areas (SMSA's) previously identified. The SMSA's selected are major net importers of softwood lumber

products. Certain SMSA's selected are major net importers of softwood lumber products. Certain SMSA's in areas such as Montana and Oklahoma were not included as market areas, since the amount of softwood lumber produced in those areas is greater than the estimated softwood lumber consumption within the respective SMSA. It was assumed that Colorado mills could not be competitive in areas with a large local wood product production capacity.

Local markets in Colorado and Wyoming that would be affected by the coal, mineral, and related energy developments were also analyzed. These local markets included anticipated future needs of wood for housing and for mine timber uses.

The percentage of ponderosa pine and spruce-fir used to determine programmed harvest cut and potential yield breakdowns were developed from the sawtimber raw material resource data. They represent that percentage of the total volume that each timber type comprises of the total raw material resource in the designated timber procurement area for each cluster.

The raw material resource grades were derived by using Forest Service timber sale appraisals data and mill information concerning the amount of green resource material used by the mills to make higher valued products. Thus, in the cluster analyzed in this report, the following breakdowns for resource grades were used in defining the total raw material base available to the sawmills in southwestern Colorado.

The Raw Material Resource Grades for the Market Cluster follow:

Cluster	Green #1	Green #2	Deadwood
Southern Colorado[1/]	.680	.227	.093

Green #1 is the proportion of the raw material base suitable for high valued products such as planed boards or paneling. Green #2 is the proportion of the raw material suitable for lower valued products such as dimension lumber. Deadwood can be used for products such as fence posts or firewood. Certain products could use more than one type resource. For example, dimension lumber could use green #1 or green #2. There are a

1/The actual proportion of deadwood was .093 based upon the timber sales appraisal sheets for the market cluster area. The remaining .907 was divided into 3/4 green #1 and 1/4 green #2 based on the products currently being manufactured.

total of 210 variables in the LP formulation. There are 24 inequalities in each model, and one objective function. The coefficients for the objective function are the residual values for each product at each of the five market distances, based upon timber types. The overriding objective assumes the mills allocate product mixes to markets to maximize residual values (location rent).

The coefficients for the variables used in the raw material equations show the recovery factor for mill production by individual product. They were derived as follows:

Recovery Factor for Planed Board Products:

$$\frac{18.18}{5 \times 1.10} = 3.31$$

18.18 - conversion multiplier MBF to MCF for milling and final product. For example, 18.29 MBF of planed boards is required for 1 MCF.

5 - conversion multiplier MBF to MCF for raw material resource

1.10 - overrun percentage based on mill production return estimates by MBF for planed boards. For example, 1.1 MBF of planed boards requires 1 MBF of raw material.

The 3.31, in this example, becomes the MCF's of raw material necessary to develop one MCF of planed boards. A similar procedure was followed for all other products using their respective milling and final product conversion multipliers and overrun percentages (See Table 5 and Appendix I of RM 4251-21).

A coefficient of one (1) is utilized for the mill capacity and marketing relationships. This simply connects the volume of the products output to the mill production and market demand constraints.

There are three basic sets of equations used in each analysis. They deal with mill capacity, the raw material resource base, and market zone consumption levels.

For mill capacity there are seven equations[1/] based on product lines, and both actual annual (current) mill capacity and potential annual mill capacity. The actual, current mill capacities are based on what the mill is presently (1977) producing in each product category. The potential mill capacity inflates these figures to reflect a 240 day full time production schedule. This formulation is necessary to more accurately represent the actual situation in the cluster, and to allow a more reasonable estimate of impacts. It does, however, constrain the shifting of one product line to another, which could occur in reality. For example, shifting production from dimension lumber to mine timbers. Without specific information concerning how these shifts would impact overall capacity, it is difficult to model the effect of these shifting product lines. It is, therefore, handled in a qualitative fashion by examining shadow prices to see where increasing production capacity would be most beneficial.

Since the actual production figures are based on 1977 production, some disparities exist in the figures. For example, actual mill production is higher than the programmed cut figures or estimated volume available. This occurs because 1977 was a strong year in the housing area and mills used past inventory (timber purchased in previous years) to take advantage of the market. Further, 1977 was a mild year in terms of winter weather that made logging feasible for a longer period and supplied a larger timber volume than is normally the case. Also substantial salvage sales that were not programmed may have occurred. Thus, the discrepancy between programmed cut and actual mill production figures in 1977 should be considered as being the largest possible given that the mills were taking advantage of a strong housing market.

The following tables give the right-hand-side acronyms used in the linear programming package.

[1/] This is three fewer than used in RM 4251-21 because the mills in southern Colorado do not produce pallets, fence posts, or utility poles.

Table I-2. Mill Capacity Right-Hand-Sides

RHS	Product Lines
SAWMILL 1	Planed Boards, Paneling, Joists
SAWMILL 2	Rough Boards, Fencing
SAWMILL 3	Dimension Lumber
SAWMILL 4	Studs
SAWMILL 5	Timbers, Railroad Ties
HOUSELOG	Houselogs
FIREWOOD	Firewood

There are six equations which make up the raw material resource base. They are defined by timber type and resource grades, and are as follows:

PPGRN 1	Ponderosa Pine	Green #1
SFGRN 1	Spruce-Fir	Green #1
PPGRN 2	Ponderosa Pine	Green #2
SFGRN 2	Spruce-Fir	Green #2
PPDEAD	Ponderosa Pine	Deadwood
SFDEAD	Spruce-Fir	Deadwood

These are specified in terms of programmed harvest cut and potential yield on an annual basis. The programmed cut covers Forest Service and BLM lands, while potential yield covers Forest Service, BLM, and State and Private lands.

There are ten market zone consumption level equations. They identify those market areas within the five market distances where Colorado would be most profitable and have had the most success in marketing their products. The ten market areas examined all fall within one of the five marketing distances previously discussed, classified according to how far these areas are located from the central base city in the cluster. This center city for the Southern Colorado Cluster is Durango, Colorado.

The ten market clusters used in the linear program analysis are as follows:

COLOSMSA	Colorado SMSA
COLHOUSE	Colorado Housing (includes 9 counties directly impacted by coal development)
COLOMINE	Colorado Mining (includes 9 counties directly impacted by coal development)
WYOHOUSE	Wyoming Housing (includes 9 counties directly impacted by coal development)
WYOMINE	Wyoming Mining (includes 9 counties directly impacted by coal development)
KMSMSA	Kansas-Missouri SMSA
IOWASMSA	Iowa SMSA
MWSMSA	Minnesota-Wisconsin SMSA
ILLSMSA	Illinois SMSA
WISCSMSA	Wisconsin SMSA

All of these are identified previously in this report on a map of the United States.

All right-hand-side values as well as objective function coefficients are defined on the basis of 1977 data - costs, returns, mill capacities, raw material levels, and market consumption levels. All product and raw material values are in terms of MCF (Thousand Cubic Feet).

Six alternatives or scenarios are analyzed for the Southern Colorado Cluster. For each scenario different right-hand-side values are substituted for either or all of the mill capacity, raw material resource base or market zone consumption level equations. The following is a brief descriptive list of the six scenarios presented by market cluster[1/].

Scenario I - Current mill production with programmed allowable cut.

Scenario II - Current mill production with potential yield.

Scenario III - Current mill production with potential yield less RARE II "Instant" wilderness areas.

1/ The LP analysis in RM 4251-21 lists seven scenarios. Scenario II in this analysis corresponds with scenarios II and IV in RM 4251-21 because the further planning areas are included within the RARE II set-asides. Likewise, scenario V in this analysis corresponds with scenario VI in RM 4251-21.

Scenario IV - Potential mill capacity with potential yield.

Scenario V - Potential mill capacity with potential yield less RARE II instant wilderness.

Scenario VI - Potential mill capacity with potential yield less RARE II instant wilderness with local energy impact markets.

(Note: The term 'instant wilderness' is taken directly from the final U.S. Forest Service impact statement concerning RARE II. Those areas designated are in fact only recommendations for inclusion into the National Wilderness Preservation System).

This analysis presents, in both tabular form and narrative, a discussion of the LP results for each scenario. After analyzing each scenario, a summary presentation is developed pointing out tradeoffs between scenarios.

The opportunity costs listed represent the potential increase to the total revenue for the marketing cluster if the output associated with that cost were increased by one unit. The cost takes into account all raw material and demand constraints that would require a transfer of material from one product to another including all revenues lost and gained.

Scenario Analysis of the Southern Colorado Marketing Cluster

Scenario I: Current Mill Production with Programmed Cut

Table II-4. Linear Program Allocation

Product	MCF Produced	Market Area	Species and Resource Grade	Opportunity Cost for Expansion of Mill Product Capacity Per MCF [1]
1. Planed Boards	301	Minnesota, Wisconsin, and Illinois SMSA's	Spruce-Fir Green #1	$2717.29
2. Studs	87	Iowa SMSA	Ponderosa Pine Green #1	0.00 [2]
	29	" "	Ponderosa Pine Green #2	0.00
	259	" "	Spruce-Fir Green #1	0.00
	23	" "	Spruce-Fir Green #2	0.00
3. Timbers	19	Wyoming Housing and Mining and Kansas-Missouri SMSA's	Ponderosa Pine Deadwood	809.96
	201	Iowa SMSA	Spruce-Fir Green #2	809.96
	125	" "	Spruce-Fir Deadwood	809.96
4. Fencing	159	Colorado Housing	Spruce-Fir Green #2	879.16

1/ The opportunity cost is the net additional value of one more MCF of product output. It is net in that there is a transfer of raw material from a lower valued product to one with a higher value.

2/ Excess mill capacity for studs is available (1446 MCF), therefore no opportunity cost exists.

Total Residual Value: $3,051,000

Total Excess Mill Capacity of 6364 MCF.

Scenario II: Current Mill Production with Potential Yield

Table II-5 Linear Program Allocation

Product	MCF Produced	Market Area	Species and Resource Grade	Opportunity Cost for Mill Product Capacity Expansion (MCF) [1]
1. Planed Boards	301	Minnesota, Wisconsin, and Illinois SMSA's	Spruce-Fir Green #1	$3953.01
2. Dimension Lumber	2593	Wyoming Housing and Kansas-Missouri SMSA	Spruce-Fir Green #1	0.0 [2]
3. Studs	615	Iowa SMSA	Ponderosa Pine Green #1	1187.18
	272	" "	Spruce-Fir Green #1	1187.18
	956	" "	Spruce-Fir Green #2	1187.18
4. Timbers	334	Iowa SMSA	Spruce-Fir Deadwood	1556.61
	10	" "	Spruce-Fir Green #2	1556.61
5. Houselogs	243	Colorado Housing	Ponderosa Pine Green #2	267.31
	100	" "	Ponderosa Pine Deadwood	267.31
	238	" "	Spruce-Fir Deadwood	267.31
6. Fencing	159	Colorado Housing	Spruce-Fir Green #2	1189.03

1/ The opportunity cost is the net additional value of one more MCF of product output. It is net in that there is a transfer of raw materials from a lower valued product to one that has a higher value.

2/ Excess mill capacity for dimension lumber is available (1,745 mcf), therefore no opportunity cost exists.

Total Residual Value: $7,905,900

Total Excess Mill Capacity of 1,745 mcf.

Scenario II

With the mills operating at their current production level and the raw material resource base increased from the programmed allowable cut to its potential yield, the mills still exhaust all available raw material and operate at 77% of their current capacity to produce. This is a 61% increase in mill capacity use above the previous scenario and represents an increase of 4619 MCF of final product. To achieve total current mill capacity the raw material supply would have to be increased by 5183 MCF. Under these conditions it would be expected that there would still be competitive bidding for stumpage and there is adequate mill capacity to support an intensive timber management program.

The production of planed boards is the top priority product line using only spruce-fir, green #1 and composing 5% of the total output. The current capacity to produce studs utilizes ponderosa pine, green #1, spruce-fir, green #1, and spruce-fir, green #2. The current production of houselogs uses ponderosa pine and spruce-fir deadwood and ponderosa pine, green #2. The current production level of timbers is met mostly with spruce-fir deadwood and some spruce-fir, green #2. The remaining supply of spruce-fir, green #1 is used to produce dimension lumber.

Minnesota, Wisconsin and Illinois receive all of the planed boards, Iowa receives all of the studs and 97% of the timbers, Wyoming, Kansas, and Missouri receive all of the dimension lumber, and Colorado Housing receives all of the houselogs and fencing.

The effect of increasing the allowable cut to the potential yield is an increase in the residual value from $3,051,000 to $7,905,900, an increase of 159% (see table II-16). While it is necessary to have diversity in the production section in order to generate the highest returns (given the raw material supply), it is advisable, if possible, to increase the production of planed boards and timbers by transfer of raw materials from those product lines with significantly lower opportunity costs.

Scenario III: Current Mill Production with Potential Yield less RARE II Instant Wilderness Set Asides

Table II-6. Linear Program Allocation

Product	MCF Produced	Market Area	Species and Resource Grade	Opportunity Cost for Mill Product Capacity Expansion (MCF) [1]
1. Planed Boards	301	Minnesota, Wisconsin, and Illinois SMSA's	Spruce-Fir Green #1	$3953.01
2. Dimension Lumber	2508	Wyoming Housing and Kansas-Missouri SMSA	Spruce-Fir Green #1	0.0 [2]
3. Studs	609	Iowa SMSA	Ponderosa Pine Green #1	1187.18
	304	" "	Spruce-Fir Green #1	1187.18
	931	" "	Spruce-Fir Green #2	1187.18
4. Timbers	319	" "	Spruce-Fir Deadwood	1556.61
	25	" "	Spruce-Fir Green #2	1556.61
5. Houselogs	241	Colorado Housing	Ponderosa Pine Green #2	267.31
	98	"	Ponderosa Pine Deadwood	267.31
	240	"	Spruce-Fir Deadwood	267.31
6. Fencing	159	"	Spruce-Fir Green #2	1189.03

1/ The opportunity cost is the net additional value of one more MCF of product output. It is net in that there is a transfer of raw material from a lower valued product to a higher valued product.

2/ Excess mill capacity for dimension lumber is available (1830 MCF), therefore no opportunity cost exists.

Total Residual Value: $7,849,800

Total Excess Mill Capacity of 1830 MCF.

Scenario III

With the mills operating at the current level of production and the raw material resource base at the potential yield level less RARE II set asides, the raw material base is again exhausted. The mills are producing at 75% of their current output capacity, just slightly below the output of scenario II.

The product mix is the same as for scenario II. Planed boards, timbers, studs, houselogs, and fencing are still high priority products and their total outputs do not change. Only dimension lumber has a reduction in its output.

There was a change in how the resource was utilized. The output levels of products is maintained by a shift in the allocation of the raw materials. Studs gain spruce-fir, green #1, from dimension lumber. Houselogs compensate for the loss of ponderosa pine, green #2 and deadwood, by receiving more spruce-fir, deadwood, from timbers, and timbers compensate for the loss of spruce-fir, deadwood, by receiving more spruce-fir, green #2, from studs. Overall, the impact of RARE II set asides is slight and reduces the total residual value from $7,905,900 to $7,849,800, a decrease of .7% (see Table II-16).

Scenario IV Potential Mill Capacity with Potential Yield

Table II-7 Linear Program Allocation

Product	MCF Produced	Market Area	Species and Resource Grade	Opportunity[1] Cost for Mill Product Capacity Expansion (MCF)
1) Planed Boards	602	Minnesota Wisconsin, and Illinois, SMSA's	Spruce-Fir Green #1	$3,953.01
2) Dimension Lumber	466	Wyoming Housing and Kansas-Missouri SMSA's	Spruce-Fir Green #1	0.0[2]
	544	" "	Spruce-Fir Green #2	0.0
3) Studs	615	Iowa SMSA	Ponderosa Pine Green #1	1,187.18
	1946	" "	Spruce-Fir Green #1	1,187.18
4) Timbers	545	Iowa SMSA	Spruce-Fir Green #2	1,556.61
5) Houselogs	243	Colorado Housing	Ponderosa Pine Green #2	267.31
	100	"	Ponderosa Pine Deadwood	267.31
	114	"	Spruce-Fir Green #2	267.31
	486	"	Spruce-Fir Deadwood	267.31
6) Fencing	217	Colorado Housing	Spruce-Fir Green #2	1,189.03

1/ The opportunity cost is the net additional value of one more MCF of product output. It is net in that there is a transfer of raw material from a lower valued product to a higher valued product.

2/ Excess mill capacity for dimension lumber is available (5,661 MCF), therefore no opportunity cost exists.

Total Residual Value: $10,426,000

Total Excess Mill Capacity of 5661 MCF.

Scenario IV

With the mills operating at potential mill capacity and the raw material resource at the potential yield level all of the raw material resource is exhausted with the mills achieving 51% of potential capacity. To achieve total potential mill capacity the raw material supply would have to be increased by 16,813 MCF or a 100% increase.

Because the limiting raw material constraint is the same as in scenario II, it would be expected that the increased mill production capability in producing higher valued products would result in a transfer of raw materials from the low opportunity cost products into the higher opportunity cost production. This did occur in this scenario as shown by the reduction of dimension lumber and the transfer of its input, spruce-fir, green #1, into the production of other higher valued products. The final product lines and their points of distribution are ths same as in scenarios II and III. Although the raw material supply is the same as in scenario II, the transfer from products with a lower opportunity cost into products with a higher opportunity cost results in an increase of the total residual value from $7,905,900 to $10,426,000, an increase of 32% (see Table II-16).

Scenario V Potential Mill Capacity with Potential Yield less RARE II Instant Wilderness

Table II-8 Linear Program Allocation

Product	MCF Produced	Market Area	Species and Resource Grade	Opportunity[1] Costs for Mill Product Capacity Expansion (MCF)
1) Planed Board	602	Minnesota, Wisconsin, and Illinois SMSA's	Spruce-Fir Green #1	$3,953.01
2) Dimension	408	Wyoming Housing and Kansas-Missouri SMSA's	Spruce-Fir Green #1	0.0[2]
	516	" "	Spruce-Fir Green #2	0.0
3) Studs	609	Iowa SMSA	Ponderosa Pine Green #1	1,187.18
	1952	" "	Spruce-Fir Green #1	1,187.18
4) Timbers	545	Iowa SMSA	Spruce-Fir Green #2	1,556.61
5) Houselogs	240	Colorado Housing	Ponderosa Pine Green #2	267.31
	99	"	Ponderosa Pine Deadwood	267.31
	126	"	Spruce-Fir Green #2	267.31
	478	"	Spruce-Fir Deadwood	267.31
6) Fencing	217	Colorado Housing	Spruce-Fir Green #2	1,189.18

1/ The opportunity cost is the net additional value of one more MCF of product output. It is net in that there is a transfer of raw material from a lower valued product to a higher valued product.

2/ Excess mill capacity for dimension lumber is available (5,747 MCF), therefore no opportunity cost exists.

Total Residual Value: $10,370,000

Total Excess Mill Capacity of 5,747 MCF.

Scenario V

With the mills operating at full potential production and the raw material supply at the potential yield less RARE II set asides, the raw material supply is exhausted and the mills are operating at 50% of their potential capacity. To achieve total potential mill capacity the raw material supply would have to be increased by 17,068 or a 102% increase. Total residual value reduced from $10,426,000 to $10,370,000, a decrease of .5%.

Overall, the impacts of the RARE II set asides is, again, slight. The product mix, points of marketing, and analysis are the same as for scenario IV.

Scenario VI Potential Mill Capacity with Potential Yield less RARE II Instant Wilderness with Local Energy Impact Markets

Table II-9 Linear Program Allocation

Products	MCF Produced	Market Area	Species and Resources Grade	Opportunity[1] Costs for Mill Product Capacity Expansion (MCF)
1) Planed Boards	602	Minnesota, Wisconsin, and Illinois SMSA's	Spruce-Fir Green #1	$3,953.01
2) Dimension Lumber	408	Wyoming Housing Kansas-Missouri SMSA's	Spruce-Fir Green #1	0.0[2]
	516	" "	Spruce-Fir Green #2	0.0
3) Studs	608	Iowa SMSA	Ponderosa Pine Green #1	1,187.18
	1952	" "	Spruce-Fir Green #1	1,187.18
4) Timbers	545	Iowa SMSA	Spruce-Fir Green #2	1,556.61
5) Houselogs	240	Colorado Housing	Ponderosa Pine Green #2	267.31
	99	"	Ponderosa Pine Deadwood	267.31
	126	"	Spruce-Fir Green #2	267.31
	478	"	Spruce-Fir Deadwood	267.31
6) Fencing	217	Colorado Housing	Spruce-Fir Green #2	1,189.03

1/ The opportunity cost is the net additional value of one more MCF of product output. It is net in that there is a transfer of raw material from a lower valued product to one that is higher valued.

2/ Excess mill capacity for dimension lumber is available (5,747 MCF), therefore no opportunity cost exists.

Total Residual Value: $10,370,000.

Total Excess Mill Capacity of 5,747 MCF.

Scenario VI

The only difference between the set up for scenario VI and scenario V is the increase in the demand for wood products as a result of energy growth in Colorado and Wyoming. The demand for wood products for housing is increased from 1,079 MCF to 2,167 MCF in Colorado and from 2,883 MCF to 7,110 MCF in Wyoming. The demand for wood products for mining, timbers and railroad ties, is increased from 963 MCF to 9,071 MCF in Colorado and from 220 MCF to 2,154 MCF in Wyoming. In all of the previous scenarios those products shipped to the above markets affected by the potential mineral and energy development did not fill the demand for wood products. Thus, because these markets were not a binding constraint before the effect of the increased demand due to energy development, the output levels, raw material supply allocations, opportunity costs, would not be expected to change. This was the case here. Unless local demand creates increases in local wood product prices the firms will still be better off to ship to more distant markets.

Summary of Southern Colorado Cluster Analysis

The analysis of the Southern Colorado Cluster reveals that the raw material supply is the only constraint for all six scenarios. Spruce-fir constitutes the greatest volume of raw material supply, is the cheapest, and is used in producing most of the products. Ponderosa pine is used primarily for the production of studs and houselogs. Increasing the programmed allowable cut to the potential yield will significantly increase the total residual value within this cluster. A potential yield, intensive timber management program is possible in this cluster given current mill capabilities. The RARE II wilderness restrictions and future energy growth has only a minor impact upon total output and residual value and no impact upon the product mix and its distribution to the markets.

The results of this analysis suggest a utilization pattern somewhat different than the actual situation. Ponderosa pine is used by most of the smaller mills to produce mine timbers and railroad ties. The species is not used for studs. The mills claim that using ponderosa pine for studs results in warping. However, ponderosa pine has been considered technologically capable of producing satisfactory studs if adequate drying procedures are used. The analysis here considers this type production feasible and indicates that larger profits might be attained if mills produced studs.

A second difference between this analysis and the actual situation involves the market allocation. The analysis assumes the mills are capable of and willing to sell to any market area where the highest residual value occurs for the product. In reality, certain mills here are part of major firms with distribution yards centrally located in the Midwest. They ship to these company yards. Whether the economies of scale of such operations result in higher profits than the distribution indicated in this analysis is not known. In any case, firms not affiliated with such yards should find the distribution indicated by the program the most profitable.

With the raw material resource set at the programmed harvest cut level and mills producing at their current level, the mills will utilize all available raw material while operating at 16% of their current capacity. Under this situation, where the supply of timber is the constraining factor, mills could be expected to competitively bid for material and possibly attempt to import raw material from outside their traditional procurement area. The more desired raw material of the two analyzed in this report (ponderosa pine and spruce-fir) is spruce-fir (see opportunity cost in Table II-5. Spruce-fir typically has lower stumpage, procurement, and transportation costs associated with it.

The most desirable products would be those with the highest residual value. These products would receive priority for the available raw material. In this scenario the most desirable product was planed boards which utilized only spruce-fir, green #1 and production was limited by availability of this resource. The production of timbers utilizes all of the deadwood (both species) and some spruce-fir, green #2. Fencing also uses spruce-fir, green #2. The remainder of green #1 and green #2 for both species is utilized for the production of studs. There is considerable (1446 mcf) excess stud capacity remaining.

The optimum marketing distance for each product depends upon the difference between the revenues at different marketing centers and the transportation costs necessary to serve those markets. Lower priced products tend to be marketed within a distance closer to the point of production; higher valued products, farther away. Under those conditions, Minnesota, Wisconsin, and Illinois receive all of the planed boards; Iowa receives all of the studs and 95% of the timbers; Wyoming, Kansas, and Missouri receive 5% of the timbers, and Colorado Housing receives all of the fencing.

In order for Colorado Housing to be competitive with markets at greater distances, prices would have to increase to 22% for planed boards and 8% for studs. For firewood to become economically feasible, that is, to compete with the production of timbers, its price would need to be raised approximately 250%.

The overall key constraint is the raw material supply. It would be advisable to increase the production of planed boards by transferring the use of raw materials from the other mill products with lower opportunity costs.

Table II-10 Comparison of Residual Values, Excess Mill Capacity and Excess Raw Material for Scenarios I-VI

Scenario	Residual Value	Excess Mill Capacity MCF	Excess Raw Material MCF
I	3,051,000	6364	0
II	7,905,900	1745	0
III	7,849,800	1830	0
IV	10,426,000	5661	0
V	10,370,000	5747	0
VI	10,370,000	5747	0

III. Fuelwood Concentration Yards

Introduction

Questionable energy availability and sharply rising energy costs have created much interest in alternative fuels. Since 1973 the interest in using wood as an alternative fuel has led to a tenfold increase in annual sales of wood burning appliances--currently 1 1/2 million units exist nationwide.[1/] Table III-1 and Figure III-1 serve to illustrate

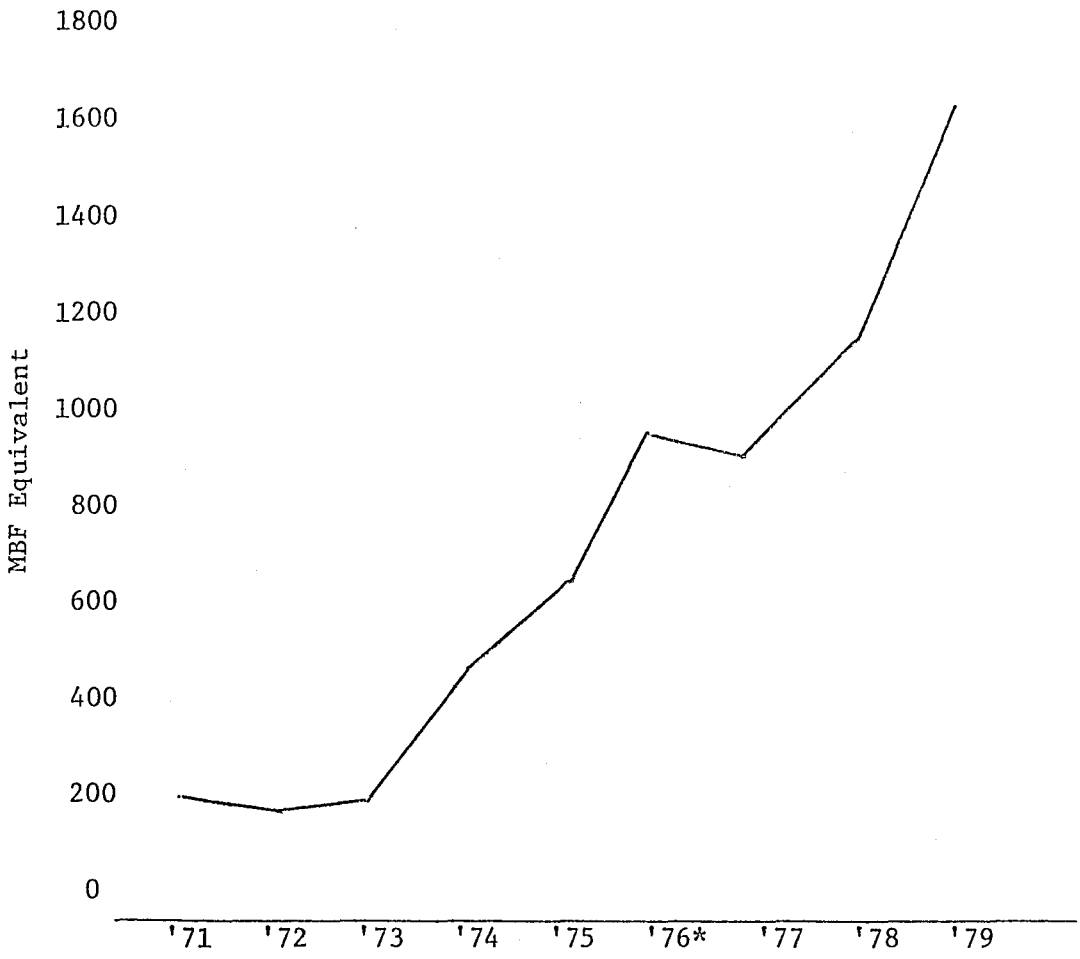
Table III-1[2/]
Estimated Timber Taken From National Forests by Free Use Permits and From Designated Free Use Areas by Region; No. of Permits Issued and Estimated Users
FY 1979

Region	Total Volume (MBF)	Total Value ($)	Total Permits Issued	Estimated No. of Users (Free Use Areas--No Permits Required)
1	185,062.6	125,881.43	25,421	31,613
2	75,796.5	74,833.75	10,431	89,554
3	208,219.2	707,013.01	41,532	68,406
4	251,563.5	646,768.02	101,791	11,961
5	207,491.9	724,719.61	60,709	9,012
6	363,454.7	648,951.10	130,904	1,325
8	216,459.0	646,359.00	75,634	352
9	127,356.0	249,000.64	33,747	1,466
10	1,117.9	11,826.88	319	5,552
Totals	1,636,521.3	3,835,353.44	480,488	219,241

1/ Shapiro, Andrew. 1979. Formerly with the Wood Energy Institute.

2/ White Paper-National Forest Free Use Program. Division of Timber Management, USDA Forest Service, Washington, D.C.

FIGURE III-1[2/]
Estimated Volume of Fuelwood Removed From
National Forest Systems Lands



*Includes Transition Quarter between FY 76 and FY 77

the increased demand for wood raw material as a source of domestic heat.[2/] The growth in demand for free use firewood has been dramatic, increasing sevenfold since 1973. With this increased demand, there is a growing need for a dependable supply system for quality fuelwood.

Where the demand for fuelwood has been greatest firewood concentration yards have developed. The extent of these commercial fuelwood suppliers varies across the country (see Table III-2). For example, in USDA Forest

Table III-2
Free Use Compared to
Commercial Sales, FY 1979

Region	Free Use Volume MMBF	Sale Volume MMBF	Percent Free Use
1	185	1260	15
2	76	443	17
3	208	435	48
4	252	463	54
5	209	2097	10
6	363	5078	7
8	216	1252	17
9	127	654	19
10	1	650	1
	1636	12,332	13

Service Region 9 only 19% of the wood is supplied via free use. The rest is commercial sales. Information concerning these pioneering efforts in concentration yards of Maine and Vermont (Region 9) can be used for assessing the advantages and disadvantages of such operations.

Advantages and Disadvantages

Whether government, private, or cooperatively run, concentration yards can potentially reduce some of the major problems a consumer faces in buying wood. Establishing a market whereby a person without much investment (chainsaw, truck, splitter) can purchase smaller amounts of firewood throughout the winter could be an important advantage to the consumer. The consumer would be assured of a steady supply of dry

wood. At the same time efficiencies of scale may mean more fuelwood could be supplied at a lower cost.

When the commercial yard involves logging by experienced operators (as contrasted with individual free use), the following advantages may be incurred by land management agencies:

1. More effective fire prevention control.
2. Better control of cutting and less damage to the residual stand.
3. Reduction of potential safety hazards in felling trees and other accidents due to inexperienced wood cutters.
4. By eliminating felling and carrying out trees by the user, the user can accumulate the needed wood supply in less time.
5. The operator built road would provide better access to the raw material and allow the use of larger more efficient trucks.
6. Provide better opportunity if wood is sold at the logging site for supervision and educational and safety training.
7. Reduce the cost of administration of fuelwood sales.
8. Provide a market for low grade material.

Several fuelwood concentration yards, like in Vermont, are operated by a public agency. The idea of a public agency as a logging contractor and wholesaler of the roundwood product, namely logs, is not new. The use of public log markets was proposed by Walter J. Mead in 1964 and more recently has been proposed by Marion Clawson of Resources for the Future, Inc., Washington, D.C. (Reprint 151). Although the idea was originally intended for the sale of sawlogs to the lumber market, most of the arguments in favor of a public log market can be applied to the use of the product for firewood as well.

As visualized in this analysis, a public log market would consist of an assembly yard, grading, sorting facilities and services for sales, primarily by periodic auction. Any public agency--federal, state, or county--could send its logs to the market, for such sorting, grading, and sale; and any private owner of logs would have the same privilege. The yard would be operated in such a way as to cover its costs. In terms of federal timber, the logs would be transported to the yard by private firms directly responsible to the U.S. Forest Service. Other governmental agencies could operate in a similar mode. The actual operation of the yard could be handled by a government agency or through a private individual under contract with the agency. Depending on the seller, a lower price limit could be set (probably to cover costs) as a minimum for auction bidding. There would be many possible bidders for the material including local sawmills, farmers/ranchers or the general public, depending on the product involved (sawlogs, posts and poles, fuelwood). Under this situation, there are advantages for the public agency, private seller and the log buyer.

1. Advantages to the public agency
    A. Elimination of timber appraisal and sale procedure
    B. Better control of the logger for environmental and reproduction protection
    C. More competitive bidding on the final product
    D. A faster response to demand because of an existing inventory
2. Advantage to the private timber seller
    A. Could bring the product from an area where there is no existing market to the government-operated concentration yard where it could be sold

3. Advantages to wood purchasers

   A. Material would be of uniform size, species and grade

   B. An assured continuous supply

There are also disadvantages concerning concentration yards and the increased use of fuelwood. The established market could, by its existence, increase the market demand for the firewood. This could be an advantage in terms of alternative energy sources but at the same time a disadvantage if the increased demand out-paced the biological potential of the timber supply.

Another concern is the environmental impact of air pollution resulting from increased use of fuelwood. Little or no emission control is now required for domestic woodstoves. Other energy sources, such as natural gas or fuel oil, have a lower pollution output and high pollution fuels, such as coal used for electricity, have tightly enforced emission control standards. The amount of pollution resulting from burning wood is dependent upon the moisture content of the wood. "Greener" wood has a higher moisture content and will emit a larger amount of particulates per unit of heat produced. To help alleviate this problem it is advisable to store the firewood for a period of approximately six months before sale. This will allow a sufficient amount of time for drying or curing and could have a significant impact in reducing air pollution.

An increase in firewood cutting would promote whole tree harvesting and reduction of in-woods slash. Also, because firewood can be utilized in a smaller form than sawtimber, firewood harvesting could promote shorter rotations in areas where it has become the primary wood use. This more frequent complete biomass removal could have an impact on site nutrient

availability. There is insufficient knowledge concerning nutrient replacement rates, but it appears that, for most forest land, natural replenishment will be affected where both whole tree harvest and short rotations are used. Of the two, short rotations appear to be the most serious. Many forests can retain their productivity following whole tree harvest, provided it occurs only once or twice a century.[3/]

Increased fuelwood harvesting will likely promote soil erosion due to the increased activity, more complete removal of slash, and disturbance of the forest floor. Past erosion has been largely determined by the quality and amount of forest road construction and skidding practices. Nutrient loss from erosion becomes especially important when combined with losses from increased biomass removal.[4/]

Using timber for fuel that is suitable for wood or fiber products may result in net reduction of the total energy supply. Sawtimber used for building materials and other products requires several times less energy than metal, brick, concrete, or plastic substitutes. The indirect energy savings from using wood for construction material may exceed the fuel energy produced by firewood for domestic heating.[5/] However, in local situations, firewood may be the only practical use of timber that would contribute to energy savings.

[3/] Nutrient Losses from Timber Harvesting in a Larch/Douglas-Fir Forest. Nellie M. Stark. USDA Forest Service Research Paper INT-231. July 1979.

[4/] Potential Losses Associated with Harvesting Forest Biomass for Energy. Robert R. Morrow. Wood-N-Energy 4(3). June 1980.

[5/] The Hidden Environmental Cost of Alternative Materials Available for Construction. C. W. Dane. Journal of Forestry 1972, 20(12), p. 734.

Operational Characteristics of Existing and Proposed Concentration Yards

Basic Organization

There have been several approaches both suggested and applied regarding concentration yard operation. Several existing and proposed approaches by federal and state agencies, cooperatives and private enterprises will be discussed concerning their operational characteristics.

Federal Government Assistance

"The need for fuelwood concentration yards has already come before Congress by its mention in Senate Bill 1996, a bill to authorize the recovery of wood residues in the National Forests for use as fuel, for conversion to use as petrochemical substitutes as wood products, and for other purposes."[6/] There are, within the bill, two new approaches to enhance the current federal programs of wood utilization. One approach called a "residual removal incentive" would, in effect, pay National Forest timber purchasers for their costs in the processing and removal of wood residues from timber sale areas to a point where it could be converted to a fuel. The second approach would establish a five-year program whose primary objective would be the development and evaluation of new and innovative means of wood residue utilization including the funding of fuelwood concentration yards and distribution centers. Part of the testing of new approaches would involve examination of various methods of accumulating residues at concentration yards or points of use, ways to assure a continuous supply, and various methods of marketing the residues.

Federal involvement here is justified on the basis of several criteria. The encouragement of wood use does enhance a shift from the reliance on

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6/ Douglas R. Leisz, Assoc. Chief Forest Service USDA at field hearing in Missoula, Montana, November 30, 1979.

nonrenewable fuels, a stated national policy. Further, many of the timberlands, at least in the West, are federally controlled. Since the federal government is a major holder of the raw material some government policy regarding fuelwood distribution is necessary. Also the encouragement of fuelwood use may help accomplish the management of timberlands for multiple uses, increase the total value of the resource, and allow for the management of previously unmanaged federal lands.

State Government

The northeastern states have been active for several years in establishing concentration yards. The State of Vermont has fuelwood concentration yards yards operated by the State Forest Service. These have been established because of the limited ability of individual users to skid trees over a long distance. Most cutting by individuals seldom extends farther than 200 feet from the roadway. In spite of the efforts of an "access road"program: the supply of firewood in Vermont ran far behind the public demand. Therefore, the concentration yard approach was instituted. In the Vermont case, the Division of Forests contracts loggers to cut and skid trees to a concentration yard located where homeowners can drive in, buck, and load firewood. A fee is collected to recover the cost of felling and skidding.

The following is Vermont's outline for their concentration yard planning:[7/]

Operational Plan

1. Delineate areas to be harvested for fuelwood
2. Locate suitable yarding site
3. Mark areas and trees to be harvested

7/ State of Vermont, Agency of Environmental Conservation Memorandum from E. Bradford Walker, Director of Forests to James E. Wilkinson, Jr., Commissioner, June 13, 1979.

Data collection:

A. Number of trees marked

B. Diameter of trees marked

C. Height of trees marked

D. Volume marked

E. Acreage marked

F. Distance (maximum and minimum) of areas marked from yarding site

4. Select logging contractor

A. Send prospectus to all logging contractors in area

B. Prospectus to include:

(1) Work to be done:

(a) Develop and improve to specifications, yarding area

(b) Cut and transport designated trees to yarding area in a manner prescribed by state

(c) Volume, measurement and acreage

(2) When work to be done

(3) Location of work

(4) Binding procedure

(5) Time, place and showing

(6) Time, place and date of bidding

(7) General and special operating conditions

C. Sign contract

5. Inform public of porgram

A. Through firewood list

B. Through news media

6. Sell wood to public

   A. Where and when

      (1) Developed camp ground

         (a) Weekends and holidays

         (b) May 1 through June 15, Labor Day through November 1 or until customer's needs are met or wood runs out, whichever comes first

      (2) Other areas

         (a) Weekends only

         (b) June 1 through Labor Day or until customer's needs are met or wood runs out, whichever comes first

7. Method of control

   A. Attendant present when yard is open

      (1) Duties:

         (a) Scale loads and collect money

         (b) Insure that safety standards are met

         (c) Have a binding release form signed by all individuals involved (bucking and loading of wood)

         (d) Administer first aid

Cooperatives[8/]

Another approach to concentration yard operation is the "cooperative." One such woodfuel cooperative has been established in Portland, Maine. The wood yard is located on an unused lot owned by the State Transportation

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[8/] Fuelwood for the Cities, Main Times, Friday, November 9, 1979.

Department and leased at $1.00 per year. The cooperative has a federal grant from ACTION for $11,000 to pay for equipment and salaries. It is seeking a second grant to continue operation for one full year. Six banks are providing a line of credit of up to $50,000 to purchase unprocessed wood from area loggers.

Coop members do most of the splitting, carrying and stacking, with the paid workers handling the chain saws. After four hours of labor, a Coop member may buy wood at $72 per cord, those unable to work would pay $82 per cord, and customers who are nonmembers would pay $90 per cord. The Maine Coop members hope to be able to take full charge of the project after the first year.

Private Enterprise

Conventional fuel prices have made privately owned fuelwood concentration yards viable economic operations in the eastern states. Wood Energy Warehouse is a privately owned concentration yard operation located in Lexington, Kentucky.[9/] The wood is purchased, already cut to length, from independent suppliers. This eliminates the expense of logging, labor, equipment, and log transportation costs. The wood is split with a hydraulic five-way wedge at a rate of 20 cords per day. It is stacked and covered with plastic for seasoning.

The wood is offered in three forms:

1. Stacks 4 feet high and 8 to 16 feet long for easy pick up for customers
2. Stacks on pallets with removable sideboards 4' x 4' x 22" which is convenient for fitting into a truck.
3. Banded bundles of 6 to 8 pieces for the one night burner or camper.

9/ Wood Heating Seminar 4, Wood Energy Institute, 1979, p. 188.

The firm reports that "pick up" customers outnumber deliveries 50 to 1.

A woodstove dealer located in Concord, New Hampshire, entered the fuelwood business to provide a reliable supply of firewood to those who purchased a wood furnace.[10/] The firm purchased a $40,000 LaFont Cordwood Processing Machine. The machine reduces 10 foot logs 5" to 18" in diameter to 18 one-foot long pieces split to stove size. Six full-time employees perform all the tasks from picking up logs from woodlots, to operating the processor, and delivering the finished product. The company buys logs from various sources at $30 to $40 per cord. The logs are hauled by the company to the processing site. The prices for a thrown cord (a thrown cord is the volume of wood filling a 144 cubic foot pickup body) delivered are $95 per cord for 1-2 cords, $90 per cord for 3-7 cords, and $85 per cord for 8 or more cords. All prices are based on delivery within the city of Concord.

Other private concentration yard operations in the Lake States and Mid Atlantic region typically have three- or four-man crews using single or double splitters. Most firewood is sold bulk but some is packaged or palletized into one-third cord units.

Fuelwood Logging Methods

Several logging methods are possible for supplying a fuelwood concentration yard. These systems are primarily designed for small roundwood averaging 6 to 7 inches in diameter. A discussion of some various possibilities follows:[11/]

1. Stump-to-Stump Logging

In stump-to-stump logging the haul truck is driven from stump-to-stump and the wood is loaded directly onto the haul truck. Chain saws

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[10/] Wood 'N Energy. Vol. 4 No. 1, Fall 1979. p. 4.

[11/] Factors Influencing the Economics of Thinning Pine Plantations. Don Tufts, Pineville Kraft Corporation.

are used to cut the trees into pulpwood lengths. The truck is equipped with a big-stick type loader to help load bundles of smaller logs or larger single logs. The haul truck is commonly referred to as a "bob" truck.

2. Pallet System

The pallet system has the advantage of allowing loading of the pallets while the main haul truck is hauling wood to the concentration yard. The cutting is done by chain saw. A crawler tractor of 60 HP to 70 HP is equipped with a big stick loader and pulls a skid pan on which the pallets may be set. A single rear axle truck pulling a tandem axle pallet trailer hauls the fuelwood to the concentration yard.

3. Chain Saw and Prehauler

The advantage of this system is that the prehauler is more mobile than the bob truck. One man with a chain saw cuts the trees and another stacks the logs in piles for the preloader. The prehauler can haul 1/10 of a cord at a time and work in fairly wet conditions allowing for a longer work season.

4. Chain Saw-Cable Skidder

This is a tree-length logging system using a chain saw to fell, top and delimb the trees. The trees are skidded out with a four-wheel drive machine equipped with a winch and a fairlead. Each tree is hooked to a choker by the machine operator and, depending upon tree size, up to six trees can be skidded to a loading area. The whole trees may be transported to the concentration yard or the trees may be bucked and split at the landing.

5. Feller Buncher-Delimbing Gate

In this operation trees are felled with a shear and an accumulating arm which dumps the trees onto the ground in 1/2 cord piles. Each pile of logs is skidded by a grapple skidder. Before loading the trees onto a logging trailer the skidder backs the trees through a delimbing gate (a pipe frame grid with 18" to 24" openings) which breaks off most of the branches. Those left are trimmed off with a chain saw.

6. Short Wood Harvester Prehauler

The short wood prehauler has a shear and delimbing head mounted on a four-wheel drive carrier. The machine severs the tree at the stump, strips off the limbs, bucks the trees into short lengths and leaves the short length wood in a pile that can be picked up by the four-wheel drive prehauler.

7. Long Wood Harvester-Grapple Skidder

This machine is similar to the short wood harvester except that it does not buck the logs but rather tops and stores them in a bunk on the back of the machine until about 5,000 pounds of logs accumulates. The pile of logs is dumped onto the ground for the grapple skidder to skid to the logging truck.

Inventory

Holding a large inventory can be a major expense for a fuelwood concentration yard operator. It takes time to season the wood and many individuals do not purchase the fuelwood until it is required in the Fall. In the meantime, the raw material must be purchased and stored by the operator. This all costs money.

Seasoning takes six months as a minimum and a year is recommended. For pine in the high, dry Rocky Mountain area this time may be shortened.

The cost of inventory could be recovered if the costs could be passed on to the consumer. For this to be possible, the public would have to be made aware of the increased benefits of using seasoned firewood.

Planning the level of inventory is often difficult because of the yearly variations in winter weather. During the cold winter of 1976-77, New England fuelwood was sold as fast as it was produced whereas in 1979-80 a large inventory of fuelwood accumulated due to the milder winter weather.[12/] Weather is very difficult to predict in advance which adds uncertainty and risk to determining the proper yard inventory level.

Theft of the fuelwood inventory is common and is a problem in concentration yards. An inventory of firewood cut and split and readily accessible near a populated area requires an expensive form of protection such as a fence or something similar. As a deterrent to theft, the wood can be stored in large sizes such as 8' bolts. The effort and time required to steal the product in this form would be discouraging to potential thieves. Another effective security approach where the fuelwood is kept in the woods is to keep the firewood in an area accessible only by a road where entrance can be secured by a gate. The long walk carrying firewood would also discourage most potential thieves.

Given the large inventory and the uncertainty associated with sales, it would be beneficial to solicit orders in advance (in the summer) offering reduced prices for ordering early. This would eliminate some of the uncertainty involved in determining what level of inventory to keep. Further, selling at a reduced price in the summer may encourage customers to buy early rather than wait. This would reduce the inventory costs. In some cases holding an inventory may be better than selling at reduced prices if prices increase greatly during the winter months.

12/ Personal Communication, Ike Sheppard, New Hampshire woodlot manager, July 21, 1980.

Location

Normally it would be advisable to locate the concentration yard near the potential market. The savings in reduced traveling expenses would be an enducement to many buyers. Because free use firewood is still available, the market of customers would probably be either those who wish to avoid the necessary expenditures (truck, chainsaw, splitter) for harvesting, or those not physically capable of the work required (for example, the elderly). Others may buy at the concentration yards to provide small quantities of wood when their own supplies have been depleted before the end of the heating season. Because of the need for seasoned wood and possible problems with timberland access during the winter months, it is likely these individuals would use a concentration yard located close by.

Product

The firewood market consists of a wide array of buyers. Who will buy the wood? How much will they buy? In what form? Answers to these questions and others concerning customer characteristics and preferences are important to the planning of the concentration yard. A survey, done as economically as possible, would be helpful in determining the market characteristics. The results of one survey are shown on the next page for illustration.[13/]

The form of the product is quite dependent upon the "types" of people within the market. Older people can't handle full length stems. People in the city do not usually have the space for full length stem storage. On the other hand an area predominantly occupied by younger people

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13/ The Firewood Producers Manual, George P. Frick. June 1979, p. 28.

Customer Preference for Various Forms of Green Fuelwood
150 Customers
825 Cords

Form	% Customers	% Volume
16" split	30	33
4' split	35	36
4' bolts	25	22
Full length	10	9

Customer Preference for Various Forms of Seasoned Fuelwood
298 Customers
1390 Cords

Form	% Customers	% Volume
12" split	23	20
16" split	41	46
18" split	12	5
48" split	24	29

may have customers willing to cut, split and load their own wood. In this case it may be advantageous to offer the product in a more crude form, perhaps 4' bolts or full logs. The customer would cut and split their own fuelwood at the yard. This would eliminate the costs of sawyers in the yard and allow the concentration yard operation to be handled by one or, at most, two people.

Currently there is an ongoing study at Colorado State University aimed at analyzing fuelwood consumer characteristics in Colorado. The results of this study should be helpful in providing information regarding consumer product needs and preferences.

Costs and Pricing

Fuelwood Logging Systems

Table III-3 shows a comparison of fuelwood logging systems, their total investment, output and unit cost. It is evident that an individual small wood contractor would not be likely to use any system other than the "chain saw-bob truck" system. Others require a much higher investment and output. Also, the benefit of the cheaper unit cost of some other systems is not significant.

Table III-3

Comparison of Investment Costs by Logging Systems*[14/]

Logging Systems	Total Investment	Cords Per Year	Cost Per Cord 6" to 7" DBH
1. Chain Saw-Bob Truck	$ 17,050	2,000	$24.61
2. Chain Saw-Pallets	59,760	5,040	23.66
3. Chain Saw-Prehauler	79,850	6,000	23.98
4. Chain Saw-Cable Skidder	149,900	4,800	31.14
5. Feller Buncher-Delimbing Gate	251,975	12,000	21.71
6. Shortwood Harvester-Prehauler	167,975	6,000	28.75
7. Longwood Harvester-Grapple Skidder	241,875	9,600	21.55

*Equipment and labor balanced to cut small timber between 6.0 and 7.0 inches Dbh. Costs do not include stumpage.

Concentration Yard Operation

In cases where logs are delivered in ten-foot lengths to the concentration yard, the following cost per man hour figures apply regarding

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[14/] Factors Influencing the Economics of Thinning Pine Plantations, Bob Tufts, 1976, p. 33, Pineville Kraft Corporation, Williams Lake Rd., Pineville, LA.

production of fuelwood. This assumes a three-man operation, a bucker, a yardsman, and a splitter operator for a single splitter.

Production[14] (cords/8-hour shift)	man hours/cord	@$5.00/hour labor cost/cord
13.04	1.84	$9.20

The Chain Saw-Bob Truck logging system and this concentration yard operation could produce a cord of wood for $33.81. This cost figure does not include transportation costs of the logs to the yard, stumpage, or overhead costs.

Concentration Yard/Logging Combined

There is also some cost data concerning operations where the company also does its own logging in conjunction with operating the concentration yard. In this case the operation involved four men with a double splitter.

Production[15] (cords/8-hour shift)	man hours/cord	@$5.00/hour labor cost/cord
6.80	4.71	23.55

While these figures are very rough approximations, they do provide an estimate of the costs involved (less transportation to the concentration yard and overhead) in producing fuelwood.

Most of the current concentration yard operations have opted to purchase logs from experienced loggers. For the most part the decision will rest upon whether the company can assemble a crew of loggers who can compete with the productivity of an experienced operation and whether the firm can afford and desires to invest in logging equipment.

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[15] Prospectus: Firewood Manufacturing and Marketing. USDA Forest Service NA-FR-17. Feb., 1980.

Figures from a recent study in Maine (Table III-4) indicate that the value added in the fuelwood production process is greatest in the latter stages of production.

Table III-4[16/]

Stage of Production	Steps Involved	Price of Final Production	Value Added
1	Purchase stumpage fell & limb skid & buck to 4' length	$12-$15/cord	$12-$15/cord
2	Haul and stack	$28-$32/cord	$16-$17/cord
3	Saw to size	$30-$50/cord	$2-$18/cord
4	Split and deliver	$50-$90/cord	$20-$40/cord

This data tends to reinforce what is in many cases the current situation. That is, for the most part, the fuelwood dealer would be better off leaving the procurement of the raw material to a subcontractor.

There are several scenarios possible concerning the yard operation. One means of operation suggested by Mead was discussed earlier. In the economic analysis that follows, to assume the yard is privately operated. It could also be operated by a government agency. Although there is a difference regarding control of the yard and advantages discussed earlier, the costs involved are reasonably the same. Thus the basic cost analysis presented next should apply regardless of whether the government or a private sector operated the yard.

16/ A Guide to Wood Heat for Maine People. College of the Atlantic. Bar Harbor, Maine, March, 1979. p. 152.

Cost Analysis for Colorado/Wyoming

This section will construct cost estimates for operating fuelwood concentration yards in the Central Rocky Mountain area. To begin, certain specifications concerning MBF conversions to cords need to be defined for the most common Rocky Mountain fuelwood species. The accepted relationship between cords and thousand board feet (MBF) is 2 cords per MBF for larger sized logs and 3 cords per MBF for smaller sized logs. Larger sized logs would be those suitable for sawtimber use. The 3 cords per MBF will be assumed to be an appropriate figure. Most fuelwood operations would be using small sized material from thinnings or other material not used for sawtimber.[17/] Also requiring definition is the volume of wood fiber contained within a stacked cord (4' x 4' x 8'). For lodgepole pine, Engelmann spruce and Douglas fir the assumed volume is 90 $ft.^3$ per cord for ponderosa pine and aspen the assumed volume is 80 $ft.^3$ per cord.

Stumpage Price

For fiscal year 1979, 8.2 MMBF of stumpage was sold at $54,347 for use as firewood in the Front Range National Forests (Arapaho, Roosevelt, Pike, and San Isabel). Removing one abnormally high bid price from these sales, the average sale price was $2.92/mbf. Applying the conversion factor for smaller timber gives

$$\$2.92/\text{MBF} \times 1 \text{ MBF}/3 \text{ cords} = \$.97/\text{cord} \quad .$$

Logging Costs

The figures for felling, bucking and skidding can be derived from the USFS timber sale appraisal handbook data for Region 2 effective December 26,

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17/ Prospectus: Firewood Manufacturing and Marketing. USDA Forest Service NA-FR-17, February, 1980. p. 14.

1978. The zone used was the Black Hills because the data is given in cords and the costs of harvesting generally apply to smaller timber. The figures below assume a 15% slope. The logging costs given here should be increased by an additional 15% for slopes of 50%.[18] This should be considered when applying this data to the generally steeper terrain of the Central Rocky Mountain area. Further, if the material purchased was solely from thinnings, the figures would also be somewhat higher.

Given these base figures and assumptions the total cost calculations become:

	Fell, Buck Limb, Lop	Skid	Load	OH	Total
Cost per MCF[18]	$96.24	$116.35	$19.97	$38.31	$270.87
Cost per Cord (.08 MCF/Cord)	7.70	9.31	1.60	3.06	21.67

This total cost is 40% to 74% above the comparable costs (considering inflation) of the stage I of fuelwood production in Maine (TAble III-4). This appears reasonable because of the more rugged terrain of the West. Although these figures are "ball park" estimates, the overall higher cost is obvious and should be considered when comparing cost data for similar procedures in the New England area.

Total Costs

A detailed plan showing a scenario for a three-man firewood operation (Table III-5) was developed in the Firewood Producers Manual. It is currently used as a guide for potential investors in the New England area.[19] Certain portions of their costs concerning capital, equipment, maintenance, and overhead can be used in this analysis for Colorado.

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[18] Timber Appraisal Handbook 01.9, July 1, 1980.

[19] The Firewood Producers Manual, George P. Frich. 1978.

Table III-5
Description of the Operation as Planned

	Stage of Operation		Hours/cord	
1.	Fell and Limb	Fell, limb & top to 3-inch dia.	Labor Chain saw	1.00 1.00
2.	Skid	Skid whole stems - avg. 450 ft. 1/3 cord in 15 minutes	Labor Tractor	0.75 0.75
3.	Buck 12-ft.	Buck to 12-foot bolts with chain saw	Labor Chain saw	0.33 0.33
4.	Load	Load 3 cords on truck with tractor. 2 men x 1-1/4 hours (÷ time by 3 cords)	Labor Tractor	0.83 0.42
5.	Forward	Haul 3 cords 15 mi. in 30 min. (÷ by 3)	Labor Truck	0.17 0.17
6.	Unload	Unload onto slope and roll to bottom with peavey - 1 hr. for 3 cords (÷ by 3)	Labor Truck	0.33 Idle
7.	Return	Another 30 min. incidental to above (÷ by 3)	Labor Truck	0.17 0.17
8.	Buck 4-ft. Bolts stockpiled at bottom of slope. Level work area.	Buck to 4-ft. length with chain saw	Labor Chain saw	0.50 0.50
9.	Split	Split bolts (over 8-inch. dia. only) with hydraulic splitter 2 men x 1/4 hour	Labor Splitter	0.50 0.25
10.	Stack	Haul an average of 200 ft. with trailer - stack in measured cords and cover top. 2 men x 1/2 hour	Labor Tractor	1.00 0.50
11.	Cut-off	Cut 2 premeasured cords to length - with circular saw powered by tractor. Toss logs into truck - now equipped with sides 2 men x 1 hour (÷ time by 2 cords)	Labor Tractor	1.00 0.50
12.	Deliver	Travel an average of 10 mi. (each way) at 30 mph. (40 min. total) and dump 2 cords of wood (20 min.) (÷ time by 2)	Labor Truck	0.50 0.33

The cost data in the Firewood Producers Manual was for 1977. Changes were made to update the costs and make them comparable to the Timber Appraisal Handbook data effective July 1, 1980, and other current area prices. These changes were:

1. The fuel cost was raised from $.60/gallon to $1.20/gallon.
2. The stumpage cost was lowered from $3.00/cord to $.97/cord as previously calculated.
3. The hauling cost was calculated assuming $200 per load,[20] 3.8 MCF per load,[20] and 3 cords per MCF. This yields $200/load ÷ 3.8 MCF/load ÷ 3 cords/load = $17.54/cord.
4. The wage rate was raised from $4.00/hour to $6.37/hour,[18] to reflect the average wage rate for woods workers in the Rocky Mountain Region. Although even higher wages are paid for equipment operators and specialized woodsmen, the nature of a private firewood business would normally not require these experienced personnel.
5. Production is assumed to be 1,000 cords per year. This will be applied to the capital equipment/fixed costs to derive a yearly cost per cord.

Cost data for the budget is given in Table III-6 and the resulting cost budget is given in Table III-7. This provides the best estimate of total production costs of a fuelwood concentration yard taking into account all fixed and variable costs in the production process. The total production cost is $73.20 per cord.

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[20] An accepted cost for trucking logs is at least $150-$200 per load for a 50-15 mile one-way trip.

[21] Forest Service Manual, title 2400. R-2 Supplement No. 192. July 1974.

Table III-6
Cost Data for Budget

Capital Equipment	Present Value	Est. Life	Depreciation Per Year
Donated by partners			
1. Truck	$1500.00	5 yrs.	$ 300.00
2. Tractor	800.00	5	160.00
3. Trailer	150.00	2	75.00
4. Splitter	500.00	5	100.00
5. Chain saws (2)	400.00	2	200.00
Purchased, made, installed, etc.			
6. Cable pulley on truck	100.00	5	20.00
7. Winch on tractor	700.00	5	140.00
8. Other mod. on tractor	400.00	5	80.00
9. Circular saw and frame	200.00	5	40.00
Total	$4750.00		$1115.00

Other Fixed Costs	Per Year
10. Insurance, licenses, etc.	$ 500.00

Variable Operating Costs	Per Hour
Labor	
11. Partners' wages	$ 6.37*
Fuel	
12. Chain saws $1.50/gal 1/4 gal./hr. =	0.38
13. Tractor $1.20/gal. 1 gal./hr. =	1.20*
14. Splitter $1.20/gal. 3/4 gal./hr. =	.90*
15. Truck $1.20/gal. 30 mph/6 mi. per gal. =	6.00*
Maintenance	
16. Chain saws (incl. 4 chains, 1 bar, wedges, files, etc.) $150/650 hrs. =	0.23
17. Tractor (incl. lube, etc., plus repair allowance) $300/640 hrs. =	0.47
18. Splitter (incl. lube, etc., plus repair allowance) $25/57 hrs. =	0.44
19. Truck (incl. lube, etc., plus repair allowance) $500/211 hrs. =	2.36

Associated Variable Costs	Per Hour
20. Administration (20% of straight labor - item 11 above)	1.27*
	Per Cord
21. Stumpage	.97*

*Costs based on Rocky Mountain R-2 Appraisal Manual Figures.

Table III-7
Cost Budget

Fixed Costs

Insurance, etc. - Due Sept. 10, beginning 1977	$ 500.00
Depreciation - To Amort. Fund Sept. 10 beginning 1978	1115.00
Total	$1615.00

Variable Costs - Due as incurred (averaged below)

		Hours		Per Cord Dollars			
		Eqpt hrs	Man hrs	Fuel	Maint.	Labor & Adm	Total Cost
Stages 1-7							
Stumpage		--	--	--	--	--	0.97
Fell and limb, skid, buck - 12 ft., load							21.67*
Hauling							17.54[19/]
Subtotal							40.18
Stages 8-10							
Buck - 4 ft.	Ch. saw	0.50	0.50	0.19	0.12	3.82	4.13
Split	Splitter	0.25	0.50	0.22	0.11	3.82	4.15
Stack	Tractor	0.25	1.00	0.30	0.12	7.64	8.06
Subtotal (*8-10)			2.00	0.71	0.35	15.28	16.34
Stages 11-12							
Cutoff	Tractor	0.50	1.00	0.60	0.24	7.64	8.48
Deliver	Truck	0.33	0.50	1.98	0.78	3.82	6.58
Subtotal (11-12)			1.50	2.58	1.02	11.46	15.06
TOTAL VARIABLE COSTS PER CORD							71.58
TOTAL FIXED COSTS PER CORD $1615/year ÷ 1000 cords/year							1.62
GRAND TOTAL COSTS PER CORD							73.20

Costs based on Rocky Mountain R-2 Appraisal Manual Figures.

Location/Hauling Costs

The question of where to locate the yard is an important one for the fuelwood supply business. It is more economical to locate the yard near the timber site and deliver the finished product (first case below) or should the logs be hauled to the urban area and the yard be established there (second case below)?

In the first case, assuming a truck carries 3.8 MCF per load or 11.4 cords/load;[21] and the distance is 75 miles one way, the round trip transportation costs are

$200/load × 1 load/11.4 cords ÷ 150 miles - $0.117/cord/mile.

(Normally a trucker will charge approximately $200/load if he can make two loads a day. If he can make only one load (because of distance), the cost per load will be approximately double. This is common in the Central Rocky Mountain area.)

In the second case, deliveries could be made from a yard located close to the urban area. In this case assume the delivery truck carries 2 cords with an average delivery distance of 20 miles. Given this type operation, the delivery cost for a cord of fuelwood can be calculated from figures in Table III-7:

$6.58/cord/delivery ÷ 20 miles/delivery - $.33/cord/mile.

It is obviously cheaper to transport logs to the urban center than to locate outside the center and deliver the product. The possibility of using a larger truck than the one used in the delivery operation would depend upon the gain in faster cycle time and a larger load as opposed to the cost of a more expensive truck. In most cases, however, it would be difficult to make urban deliveries with a larger truck. Given the higher delivery costs (more than double hauling to an urban yard) and the

large fixed costs for hauling logs any distance, it seems, for the most part, that the concentration yard would provide a cheaper product located nearer the urban center (based on haul costs).

Alternative Fuel Cost Comparison

Table III-8 shows various energy sources and their heat value for home heating. Using the actual home heating value a comparison can be made between all energy sources and their equivalent heating value in cords of wood (Table III-9).

The cost of a cord of wood is given as $73.20 (Table III-7). Using the cords/unit equivalent values, a cost for each energy source is shown in Table III-9 that is equal to the heating value of a cord of wood (green and dried) at $73.20/cord. For example, if dry natural gas sells for less than $0.012/ft.^{3}, then it is cheaper to heat with natural gas than with green pine at $73.20/cord.

Table III-8
Comparative Heat Content for Various Energy Sources

Energy source	Units	Heat content (BTU/unit)	Assumed system efficiency	Actual home heating value (BTU/unit)
Wood, pine			50%*	
Green	Cord	12.1×10^6		6.05×10^6
Air dried	Cord	13.3×10^6		6.65×10^6
Coal			70%	
Anthracite	Short ton	25.4×10^6		17.78×10^6
Bituminous	Short ton	26.2×10^6		18.34×10^6
Lignite	Short ton	12.4×10^6		8.86×10^6
Natural Gas			80%	
Wet	Cubic feet	1,095		876
Dry	Cubic feet	1,021		816.8
Liquid	Gallon	95,800		76,640
Electricity	KWH	3,412	100%	3,412

*Highest potential efficiency with an airtight woodburning stove.

Table III-9
Conventional Fuel Cost Comparison

Energy Source	Conventional Unit for Source	Cord Equiv. of Green	$ Cost of Green Pine Cord Equiv.	Cord Equiv. of Dry Pine	$ Cost of Dry Pine Cord Equiv.*	Aug. 1980 Unit Cost of Energy Source
Coal						
Anthracite	Short ton	2.94	215.21	2.67	195.44	
Bituminous	Short ton	3.03	221.80	2.76	202.03	75.00[22]
Lignite	Short ton	1.46	106.87	1.33	97.36	
Natural Gas						
Wet	Cubic feet	.000181	0.013	.000132	0.010	
Dry	Cubic feet	.000169	0.012	.000123	0.009	.0026[23]
Liquid	Gallon	.0127	0.93	.0115	0.84	
Electricity	KWH	.000564	.041	.000513	0.038	.045[24]

*$73.20 is assumed cost of a cord of wood.

It is important to note that electricity is presently the only heat source more expensive than fuelwood. Even the air dried pine is 2.7 times more expensive than coal and 3.5 times more expensive than dry natural gas.

Conclusions

The increase in demand for fuelwood has been dramatic and is likely to be perpetuated by the rising costs of traditional sources of home heat. As the more readily available supply of firewood is depleted and the demand increases, the fuelwood concentration yard may be one means of meeting the anticipated increased fuelwood needs.

There are many advantages to the use of concentration yards. From a forest management perspective, the removal of deadwood and thinnings would enhance forest management programs. Further, the yards would be a steady

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22/ A small volume coal supply company in Greeley charges $65-$75/ton for bituminous coal at 10,500-11,500 ISTU/LB. August 26, 1980.

23/ Public Service of Colorado, Natural Gas rate (dry) as of August 26, 1980.

24/ Public Service of Colorado, Residential Heating (non-demand) rate. Costs are for all KWH in excess of 1000 KWH and include all KWH adders. August 3, 1980.

and continuous supply of fuel to those people interested in using wood for home heating. Also, the wood if properly stored and seasoned in yards would reduce the air pollution and increase the heating capacity of the wood.

In general, small yard operations seem to have an advantage. The yard should be located near the urban population centers. This would reduce the cost of home deliveries and take advantage of the more efficient truck hauling operations.

The benefits of an experienced logging crew doing the cutting and hauling are quite evident. Cost advantages are incurred due to the crews efficiency. Logging crew experience is also useful with regard to proper cutting technique, area clean up, and safety.

Although experienced commercial crews should procure the fuelwood logs, it seems in the best interest of the public for the concentration yard to be operated by a public agency and the cutting to be done under a service contract. This would allow better control over the environmental impact of the logging. The logging could be more easily coordinated with other resource planning. The final product could be sold to recover the costs.

The cost of holding an inventory of firewood is difficult to determine. No "hard" economic information concerning holding costs is available. To minimize these costs, it might be recommended that customers receive a discount for firewood purchased in the summer. This might encourage customers to buy the fuelwood earlier. Sales would provide an income during this period and allow more firewood to be produced if the holding area was a restrictive factor.

The fuelwood concentration yard is basically an enterprise with four stages of production: Wood harvesting, transportation to the yard, producing the finaly product, and delivery to the customer. In Colorado and Wyoming the best estimate of total production costs for these stages is $73.20. Purchasing stumpage and logging 12-foot logs to the point of loading is 31% of the total cost, hauling the logs to the concentration yard is 24%, processing the logs into split cords of firewood is 34%, and delivering the final product to the customer is 9%. Fixed costs make up the remaining 2% of the total cost. Thus, the major costs are the processing of the final product and the stumpage price and logging of the timber. These total production costs are greater than those in the Eastern United States. Further, the heating values per cord are less for the Rocky Mountain species.

At present fuelwood supplied by a concentration yard is more expensive than other conventional fuels. However, price for both electric and gas are rising more rapidly than fuelwood prices. If this continues, commercial fuelwood concentration yards should become economically viable in many localities.

IV. Small Portable Sawmills

Introduction

Total costs of lumber production have risen drastically over the last few years. Innovative means of reducing these costs are receiving increased attention. One new (or actually revived) approach has been the development of small and usually mobile sawmills. In addition to their smaller capital investment, these sawmills offer an economic advantage to the operator by allowing mill setup on the logging site, and therefore, hauling only the final product as opposed to sawlogs. The key advantage is the reduction in shipping weight by not having to haul excess wood fiber that otherwise would be discarded during lumber production. This advantage will be analyzed in the following section as it applies to the Colorado situation.

Two distinct types of sawmills are commonly referred to as being "portable." One type has no wheels but is designed for easy shipment, breakdown, loading, and re-assembly. Another is designed to be transportable on its own wheels (which can be detachable) to allow towing from site to site. These transportable sawmills may also be called semi-mobile or mobile. The portable mills will most often utilize smaller timber and usually produce boards, studs and chips as a byproduct. The mills generally utilize material from precommercial or commercial thinning and/or small sawtimber.

For the most part, the mills are not very expensive compared to most fixed site mills. This makes their purchase feasible for a number of operators. Individuals or small partnerships would normally not find it difficult to raise the capital necessary for purchase. Given the uncertain situation concerning timber supply is some areas, this lower capital investment is particularly appealing to operators.

The types and sizes of sawmills that may be portable are varied. The following is a list of these types. The reader may consult the citations for a more detailed description of each.

Circular Sawmill[1/]

Skragg Saw[2/]

Band Saw[3/]

Edger[4/] - (for further processing of cut lumber)

Resaw[4/] - (for further processing of cut lumber)

Portable or transportable mills currently manufactured include, but are not limited to, the following:

Skragg Bolter, by Brett, Inc.

This skragg mill uses two independently powered 36" saws. The width of the saws is adjusted by the operator from 3-1/2" to 12". It can cut logs from 36" to 104" long. This unit is currently used by the Colorado State Forest Service in Golden, Colorado. The mill costs $14,500 and the two diesel engines cost $2,500 each (1977) prices).

Utilizer Portable Sawmill

This is an example of the first type circular saw mill described earlier. It has a carriage, log deck, and a 34" or 36" circular saw. This outfit is to be powered by the power take-off of a tractor with a horsepower of from 45-60 HP, depending upon the size of the saw. The mill without the tractor, costs from $6,420 to $7,615 (1979 prices), depending upon the extra features desired. An additional two saw edger may be purchased for $4,870. This piece also requires a power source of at least 15 HP or a 7-1/2 HP electric motor.

1/"Survey of Portable Sawmills," World Wood, April 1976. p. 32.

2/Small-Log Sawmill Systems in Western Canada, J. E. Aune and E. L. Lefebore, July, 1975. p. 9.

3/Survey of Portable Sawmills, World Wood, April, 1976. p. 33.

4/Small Log Sawmill Systems in Western Canada, J. E. Aune and E. L. Lefebore, July, 1975. p. 14.

Ecologizer by Garrett

This is a transportable mill that can cut logs 8' or longer and up to a 10" diameter. The machine squares the log and then rips the cant into the desired lumber. All waste wood is ground into sawdust and blown into a truck, bin, or on the ground. The cost is $68,000 (1978 prices).

Wick Transportable Sawmill

This is an example of the second type of circular sawmill where the saws and power unit move across a stationary log. As the saw is passed over the log the size of the lumber produced normally starts off small at the top of the log, becomes larger in the center of the log, and then smaller at the bottom of the log. The outfit can be powered by an electrical motor or diesel engine, and the cost ranges from $35,739 to $38,074 (1976 prices) depending upon the type of power used.

Mobile Dimension Saw

The Mobile Dimension Saw uses the same concept as the preceding Wick Transportable Saw but is smaller and does not have the more extensive assembly to align the saw. The price is less, ranging from $6,740 to $6,995 (1980). Other companies manufacturing similar equipment are Brett, Inc., of Saginaw, Mich.; Rolie's Machine Works, Inc., of Kalispell, Mont.; and Sawmill Hydraulics of Farmington, Ill.

Portable Mills in Colorado

The Colorado State Forest Products Directory lists 178 sawmill enterprises.[5/] Of the 178 mills, 27 are classified as portable.

5/ Colorado Forest Products Directory, Colorado State Forest Service, July 15, 1977. This is the most current listing of producers of primary wood products in Colorado. Because of the number of companies and the changing wood industry a few producers may have been inadvertently omitted.

Currently all the portable mills are circular type sawmills with the exception of one post and pole peeler. A summary of the production of these portable mills is displayed in Table IV-1.

Table IV-1
Capacity and Production of Portable Sawmills in Colorado

	High	Low	Average
Daily Capacity (MBF)	20	2	7.35
Average Daily Production (MBF)	13	1	4.47

The above table shows that a wide range of production levels exists for the mills. On the average, the mills produce 61% of their potential daily capacity. Eleven of the portable mills operate year-round, the remainder are seasonal.

Economic Analysis of a Portable Mill Operation

There exists a great number of methods of operation that could be applied given the various types of portable milling machinery and timber sale characteristics. Therefore, a number of simplifying assumptions have been made in this analysis to demonstrate the economic benefit of a portable mill located on the site of the timber sale (as opposed to hauling the logs to a permanent mill location). These assumptions do not represent any norm derived from a formal survey. Instead, they are established as a set of reasonable circumstances resulting from consulting with logging and milling operators and professional foresters within the State of Colorado. The assumptions are:

1. The lumber inventory point, or the permanent mill site, is located 50 miles from the site of the timber sale.

2. The portable sawmill will be the skragg type now in use by the Colorado State Forest Service, which can handle logs up to 12" in diameter. A bull edger will also be included to further process the slab and trimmings.
3. The timber to be harvested and milled will be ponderosa pine.
4. The land that could be used for a permanent site will be retained for lumber inventory, and for occasional operation and/or storage of the mill.
5. The cost of transporting a given unit weight of logs will be the same as the cost of a given unit weight of lumber. Since the trucks can carry approximately the same weight and must travel the same route; only the type of truck bed varies.[6/]
6. The distribution of log sizes to be milled will be between 5" and 12". The frequency of distribution of log sizes and the lumber recovery will be the same as for a recent recovery study (to be shown later).
7. The entire mill assembly can be transported by a lumber hauling truck at the same cost as that of a load of lumber/logs.
8. Labor costs of commuting from home to work will remain unaffected. That is they would have to commute to the site to do the logging even if the mill was located at a permanent site elsewhere.
9. The quality and price of the product will be the same whether the mill is located on site or at a permanent location.

[6/] Diamond International Corp., Fort Collins, CO. Conversation with the assistant manager on October 14, 1980.

10. The major economic benefit associated with the on-site mill centers about the net reduction in costs concerning loading/unloading and hauling logs.

11. The residues left as sawdust will be scattered over the land site. The slabs will be sold on site or transported to a point of sale. (A more detailed analysis follows later.)

A study of cubic foot recovery relative to log diameter for ponderosa pine is useful in helping estimate the reduction in hauling weight resulting from on-site milling. Table IV-2 indicates the number of logs in diameter classes from 5 to 12 inches and the cubic foot lumber recovery for a recent lumber recovery study. The study originally utilized logs from 5" to 19" in diameter but logs over 12" diameter

TABLE IV-2 7/

Cubic Foot Recovery by Log Size

LOG DIAMETER (INCHES)	NUMBER OF LOGS	CUBIC FOOT RECOVERY %
5	35	33
6	121	34
7	82	39
8	85	41
9	57	42
10	47	43
11	32	46
12	35	42

AVERAGE WEIGHTED RECOVERY FACTOR = 39%

7/ Cooperative study by Pacific N.W. Forest and Range Experiment Station, Rocky Mountain Range and Experiment Station, and Region II. An analysis of wood recovery factors of ponderosa pine at Cook Lumber, Fort Collins, Colorado. 1977.

were not included here because of the log size limit of the skragg mill. Also, the recovery study involved planed boards and timbers which yield a somewhat lower cubic recovery factor than the rough cut products the portable mill will produce. Thus, the recovery factor used may be somewhat conservative. The reduced weight from sawing on site is the total log weight minus the rough sawn lumber weight. The cost savings depends upon the amount of this reduction.

The average weighted recovery factor means that 39% of the volume of the logs could be recovered as lumber by the portable saw milling operation and 61% would be slabs and sawdust. Assuming that the density of the tree is uniform throughout it can be stated that because of on site sawing the total weight of material to be hauled to the permanent mill would be reduced by 61%.

Presently a logging contractor will charge $150-$200 [8] to haul a load of logs 50 miles. This assumes that he can complete two trips in one day and will carry approximately 50,000 pounds per load. Setting the cost of a load of logs at $175 per trip and assuming that the cost of hauling lumber is the same as that of the logs, the reduction of 61% of the weight from milling would mean a cost reduction of $106.75. Assuming the volume of a load of logs is approximately 3.8 MBF,[9] the hauling savings resulting from on site milling is $106.75/load ÷ 3.8 MBF/load - $28.09 per MBF. This means that the potential reduction in hauling costs is $28.09 times the timber volume estimated within the sale. (3.8 MBF is approximately 50,000 lbs., but since the actual weight is not used in these calculations, it is not of major significance here.)

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[8] Personal contact with an independent log hauling contractor. Sept., 1980.

[9] Timber Sales Appraisal Handbook, Title 2400, Timber Management, July 1974, R-2 Supplement #192. This shows the net volume per load of ponderosa pine in the Black Hills appraisal zone to be 3.8 MBF/load.

The fixed cost of transporting the mill to the site along with its disassembly and set up costs, is an additional cost not incurred if the mill were at a permanent location. To estimate this cost, assume that three woods laborers can dismantle and load the mill in one day and unload and reassemble the mill in one day. Using current labor rates, this gives 2 days × 8 hrs./day × 3 workers × $6.37/worker hour[10/] = $305.76 in labor costs for each setting. Assuming that a contractor would haul the mill to the timber sale site at the same rate as for a load of logs, the hauling cost becomes $175.00. Thus, the fixed cost for transporting and setting up the mill is $305.76 + $175.00 = $480.76. As the volume of timber to be milled increases, the fixed cost per unit decreases until it equals the savings per MBF from the reduced hauling cost. In this case, the breakeven point is 17.1 MBF (Figure IV-1). If the amount of timber is less than 17.1 MBF, the savings in hauling costs does not cover the extra cost of moving the mill to the site. When the portable mill processes more than 17.1 MBF of timber, it pays for the extra cost of transporting the mill and will begin to show a progressive gain over the returns made if the logs were transported to a permanent site mill 50 miles away. This breakeven volume is obviously a very small amount of timber. It would seem, given this analysis, that small sales are feasible using these portable mills and that, with the cost advantage, the portable mills should be able to competitively bid for timber.

Effects of Distance to Sale, Land Lease and Mill Size

The cost as a function of mileage is affected more by the number of trips per day than by the mileage per se.[8/] The capital or fixed cost of

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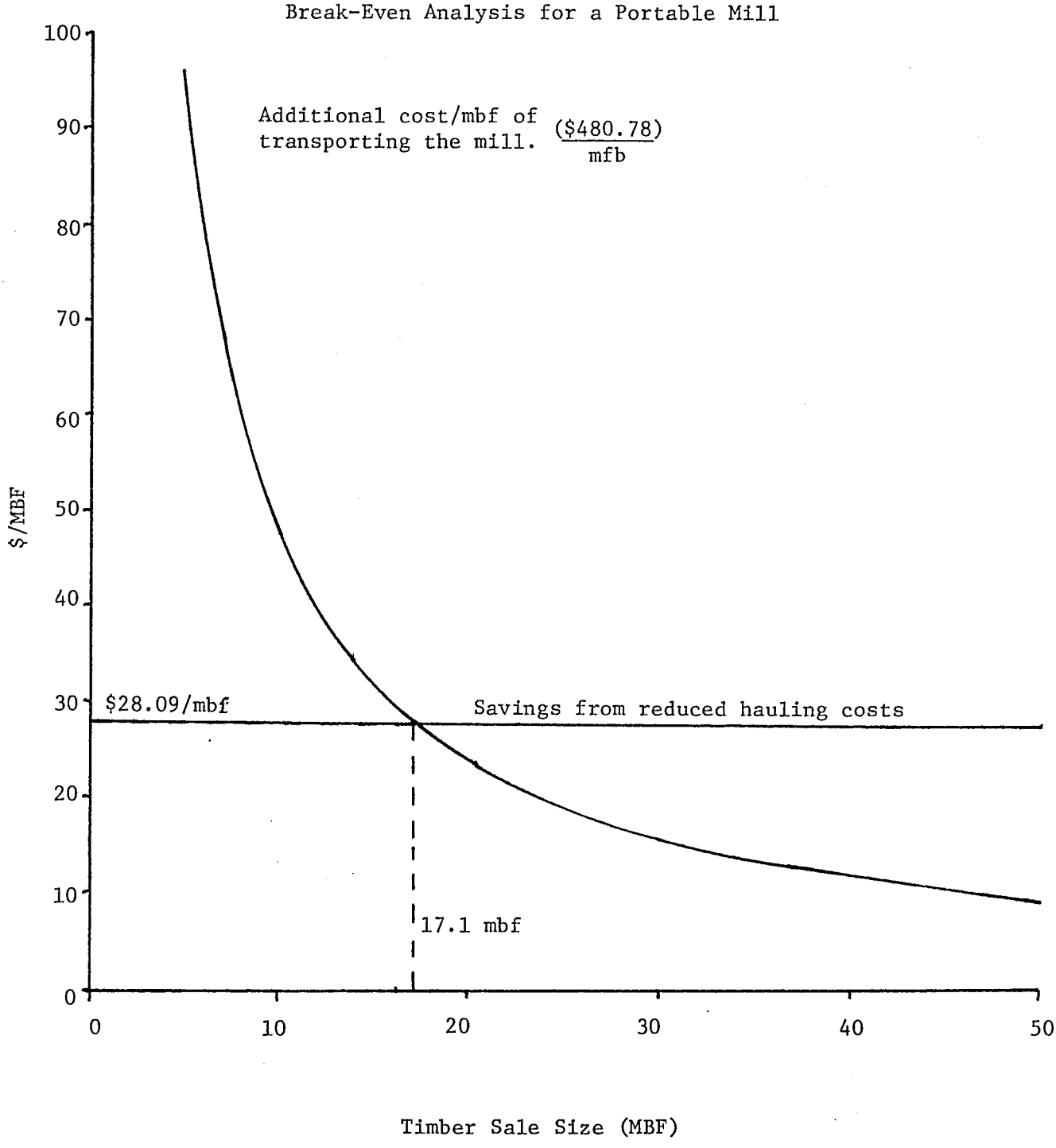
[10/] Timber Sale Appraisal Handbook, Wage Rates. $-2 FSH, 6/80 amend 25.

Figure IV-1

Break-Even Analysis for a Portable Mill



the truck is the same regardless of the number of trips made per day. Thus, the more trips per day, the less fixed cost to be recovered per trip. At 50 miles one-way, the truck would complete two trips in a day's work but at 100 miles, the truck may only complete one trip. This would result in a higher cost per trip or load. As the mileage increases, the number of trips per day decreases increasing the cost per load or cost per MBF (given the previous figures one trip per day would result in $300-$400 per load). Because the hauling costs increase as the mileage increases, the savings from reducing the weight by milling on site would become even greater.

If the sawmill were able to sell the rough green lumber as quickly as it was produced, there would be an additional savings from not needing to lease land as either holding or drying area for the lumber, but with a probable reduction in price. This could be a significant savings since leased land is normally quite expensive. However, many small mill operators would probably continue to use land, if they own it, regardless of whether they operate the sawmill there or not.

The size of the portable mill is also important. If a timber sale had trees with a DBH in excess of 12", a larger mill would be necessary, or the larger logs might be sold or traded to another sawmill. The recovery factor for larger logs is greater than that of smaller logs. The resulting waste is less and the potential savings from reduced hauling costs is therefore less. Also a larger mill may take longer to dismantle, assemble, and transport raising the fixed costs. All this would decrease the cost savings.

Disposal and Sale of Processing Residues

Processing residues resulting from operating a sawmill at the logging site must be scattered and/or removed from the site. Required methods of

disposal vary slightly within Region II but the general recommendation is that the sawdust be scattered over the landing site and the slabs be hauled away or burned. In heavy recreation use areas, it may be necessary to remove all processing residues.[11/]

Certain areas within Region II have been designated as having an available market for processing residues. In these areas an additional byproduct value of $10-$12/MBF may be used in the timber sale appraisal process. Where no market for the residues exists a cost credit of approximately $8/MBF is given in the timber sale appraisal process.[11/]

In this analysis, it will be assumed that it is necessary for the portable mill operation to remove all processing residues which are in the form of slabs. This must be done without cost credit on the timber. Currently many local sawmills have been selling part of sometimes all of their mill residues for firewood and rough construction uses. To analyze this impact, the following assumptions will be made:

1. Assuming 3 cords/MBF and 80 ft^3/cord, the residues yield would be 240 ft^3/MBF.[12/]
2. A large pickup will carry 53 ft^3 of residues (2.5' × 4' × 8' compacted to 2/3 density).
3. A large pickup load of processing residues (slabs) will sell at $15/load.[13/]

[11/] Personnel contact with Timber Management for Region II of the U.S.D.A. Forest Service. October 14, 1980.

[12/] This data is found in the preceding chapter on "Fuelwood Concentration Yards."

[13/] Personal contact with a small mill operator in Allen's Park, Colorado. September, 1980.

4. The percentage of timber volume going to residues is 51.1%.[14/] Using these assumptions, the following calculations show the value of wood residue per MBF of logs is (51.1% recovery factor) × (240 ft^3/MBF) ÷ (53 ft^3/pickup load × ($15.00/pickup load) - $37.71/MBF.

Given this residue value, the operator would be better off by operating at the permanent site (i.e., 34.71 is greater than 28.09), even if the "on site" operation could dispose of the slabs at no cost. If he were able to sell residues at the logging site for a certain "breakeven" rate or more, the best mill site location would again shift to the logging site. The following analysis calculates this "breakeven" residue price, along with its corresponding timber sale size.

The potential price range for residues will be between $15.00 per pickup load and some lower value. At $15.00 per pickup load of residues, at the logging site, the revenues equal the revenues at the permanent site and the breakeven analysis previously shown in Figure IV-1 remains unchanged. At a "breakeven" price of $2.86 per pickup load (of residues) at the logging site, the savings from lower hauling costs and the revenues from residue sales at the logging site are exactly equal. This means that at a price less than $2.86 per pickup load at the logging site, it would always be better to locate at the permanent site location, regardless of the timber sale size. In this case no amount of volume of timber could cover the fixed costs of transporting the mill because there is no net savings.

Values between $15.00 and the lower bound of $2.86 will provide a net savings if the sale is a certain size or larger. This is illustrated

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[14/] The same data and methodogy was used as in Table IV-2. This figure does not include sawdust.

graphically in Figure IV-2. If the sale is at least that size or larger (x axis) and the residues could be sold for the amount indicated or more (y axis), it would be better to operate at the logging site.

Other interpretations of Figure IV-2 can be made using the $/pickup load as a net value. For example, if the processing residues could be transported at a cost of $6/pickup load to a point of sale where the wood sells for $15/pickup load, the net revenue is $9/pickup load. Using Figure IV-2 at $9/pickup load, the size of the sale would have to be approximately 35 MBF to justify the expense of moving and setting up the sawmill.

The ability to sell logging residues at the permanent site as opposed to discarding the residues at the logging site may be one reason why most portable sawmillers do not currently operate at the logging site. The analysis of Figure IV-2 was based upon the assumption that 100% of the residues at the permanent mill site or at the logging site could be sold. As the share of residues not sold becomes greater, the economics will tend to favor the portable mill being located at the logging site (providing the slabs at the "on site" operation could be disposed of at a low cost by methods such as burning).

Discussion and Conclusions

It would appear that under certain conditions, the portable sawmill operated on the logging site could create a significant savings for the mill operator. This savings would be greater as the hauling distance increases. Since transportation costs are likely to increase as future energy costs rise, it would seem this savings will become even more significant as time goes on. Also, there exists an additional savings if the operator can sell his lumber as it is milled and avoid the cost of leasing land.

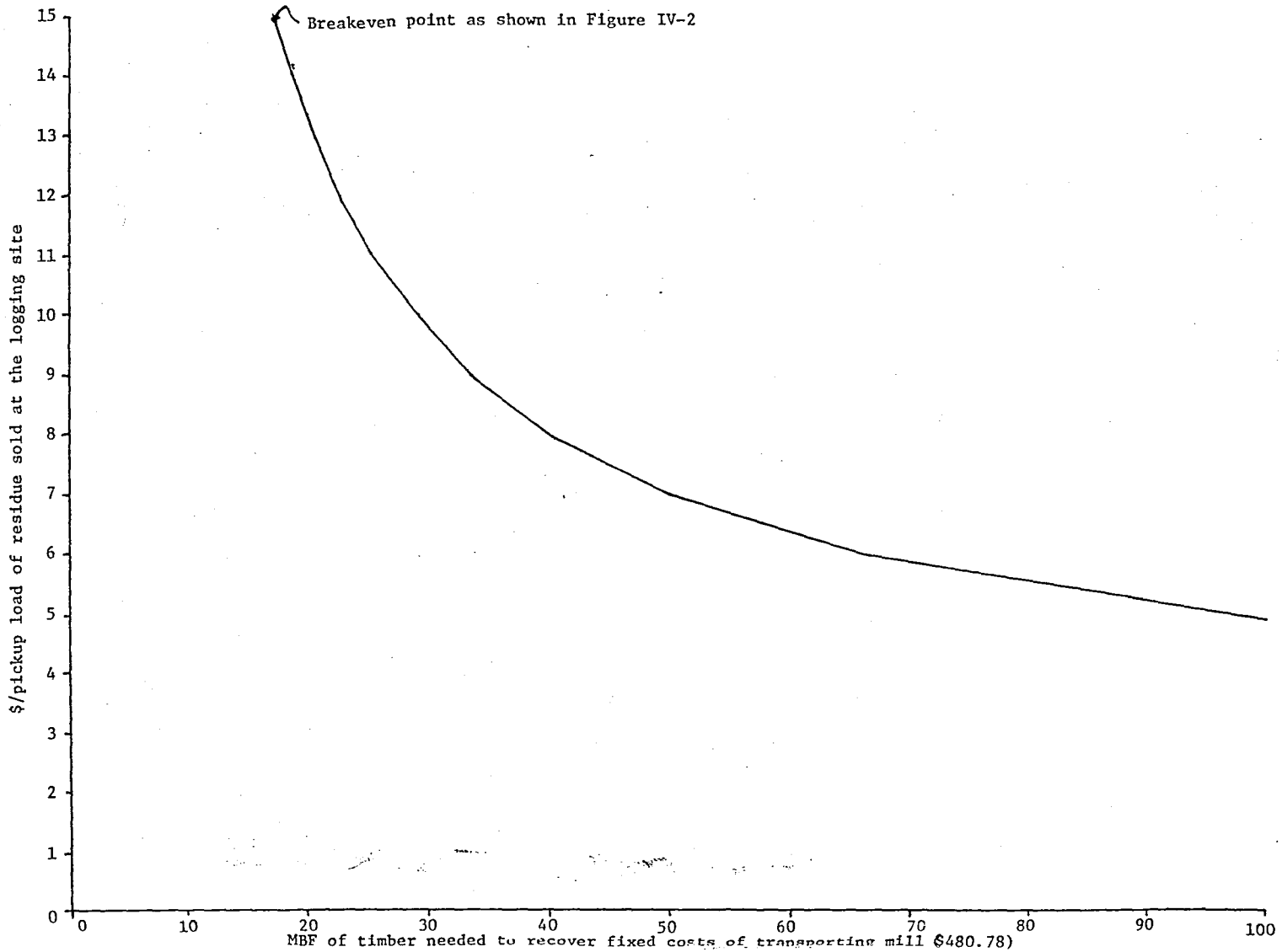
The sale and/or disposal of residues at the permanent site would appear to be a major justification for not locating the portable mill at the logging site. Some sale of residues from the logging site is necessary to justify the fixed cost of transporting the mill.

In attempting to gather cost information for the study, it becomes apparent that most mill operators used portable type mills as "permanent" mills and contracted or hauled their own logs to a fairly permanent site. Their primary reason for purchasing the portable mill was that it was easy to operate as a one- or two-man operation and it required a small capital investment. It was not purchased because it was "portable" per se. Most of the people like the convenience of having the operation close to their place of residence. In general, the operators feel more comfortable if the mill operation is in a familiar setting and consider the transporting of the mill from site to site troublesome, a possible security risk, and not worth the effort. It would seem that either the potential savings of transporting a small sawmill to a logging site is not sufficiently evident to the small mill operators or that these other considerations are more important.

Because of the smaller timber size and potential savings, it may be advantageous to use the portable mill in the future for smaller timber sales and thus enhance intensive multiple use management efforts. Most larger permanent mills will not concern themselves with sales unless they are 500 MBF or larger. The portable mills analyzed in this study would seem to be able to handle much smaller sales, on site, and could under certain conditions operate profitably in that mode to avoid long log hauls.

Figure IV-2

Breakeven point given $28.09/MBF savings from milling on the logging site and a revenue of $15.00/(pickup load) of residues at the permanent site.



V. Thermomechanical Pulp Mill - Assessment of General Economic Feasibility

Introduction

One attractive outlet for sawmill residues is for use as raw material supplies by the pulp and paper industry. Residues, often thought of as waste material, are currently providing one-fourth of the raw material used by the U.S. pulp and paper industry.[1/] Thermomechanical pulping (also referred to as TMP) is one type of pulping process which can utilize wood chips generated by sawmills such as those primarily located in the southeastern part of the United States. The pulp produced by this process has been used to produce fine papers, newsprint, sanitary and tissue papers, and paperboard.[2/] Advantages of TMP compared to chemical pulping include higher fiber yields, lower capital requirements, and less polluting effluent.

TMP can utilize manufacturing residues defined by the American Paper Institute as chips, particles, and fibers arising from primary and secondary manufacturing from sawmills, plywood and veneer mills, flooring and furniture factories.[1/] These residues include slabs, cores, edgings, shavings, and sawdust, but not bark. Excluding bark, about 55 percent of a saw log typically is residue--of this about 10 percent is sawdust, 10 percent shavings, and 35 percent chippable material.[3/] TMP can also utilize roundwood as furnish but the cost is much greater for this class of raw material.

[1/] Project Feasibility Analysis, A Guide to Profitable New Ventures. David S. Clifton, Jr. and David E. Fyffe. Georgia Institute of Technology. 1977, p. 180.

[2/] Ibid., p. 199.

[3/] TMP - Attractive Outlet for Sawmill Residues. G. E. Styan. Forest Products Journal. Vol. 28, No. 7, p. 13.

Quality control of residue is very important for TMP, which is more sensitive to the raw material quality than is chemical pulping. TMP quality is affected by the bark content in the raw material which shows up as specks and lowers the brightness of the final product. Also, if older chips are used, this can reduce the potential brightness of the pulp. And further, using sawdust and shavings will reduce the quality of the pulp as opposed to using only chips. To reduce the cost of wood fiber for TMP while maintaining an acceptable level of pulp quality, a mix of 75 percent chips and 25 percent sawdust is recommended.[4/]

Minimum Production Levels

There are about 35 TMP mills in the world, 12 of them within the United States. Their capacities range from 50 to 700 tons per day.[5/] Generally, the current minimum "economic" TMP mill uses about 200 overdried (OD) tons of fiber per day, which is at a 95 percent yield[4/] rate produces an output of 190 air dried tons of pulp per day (ADT/D). Since the mills use the wood chips green, this would mean that approximately 379 to 395 tons of green chips (or an average of about 390 tons per day) would be necessary to produce an output of 190 ADT/D of TMP.[6/] If the TMP mill operated 25 hours/day and 345 days/year,[7/] the annual pulp yield would be 65,550 ADT/year.

[4/] TMP - Attractive Outlet for Sawmill Residues. G. E. Styan. Forest Products Journal. Vol. 28, No. 7, p. 16.

[5/] Economics of Thermomechanical Market Pulpmills in the Southeastern Part of the United States. Ize I. Chiang. Forest Products Journal. Vol. 28, No. 7, p. 19.

[6/] Project Feasibility Analysis. David S. Clifton, Jr. and David E. Fyffe. 1977, p. 223.

[7/] Economics of Thermomechanical Market Pulpmills in the Southeastern Part of the United States. Tze I. Chiang. Forest Products Journal. Vol. 28, No. 7, p. 22.

Raw Material Supply in the Colorado/Wyoming Area

The economically acceptable distance for hauling raw wood material to a pulp mill depends upon the raw material cost and freight rates in the area. For the most part, 150 miles, one way, is considered a reasonable upper limit for raw material hauls to a mill. This is approximately the same as the maximum haul distance specified for the procurement areas in study RM 4251-18.[8/] In this analysis, actual cut for the same procurement areas will be used to determine the volume and weight of the manufacturing residues available. Actual cuts are used since they represent the most likely base for estimating the mill residues that would be generated annually. The weight of the actual cut volume has been calculated by species for live sawtimber volumes in each procurement area. The following formula was used to calculate the total weight of the actual cut by species:

(Total of actual cut) = (specific gravity) × (62.4 lbs/ft^3 H_2O) × (1 + moisture content) × (1000 ft^3/MCF) × (MCF of live timber)

Adding the total species weights and dividing by the total MCF of live timber gives an average weight per MCF for the area. This then can be used to estimate the total weight of actual cut. For example, the total actual cut for the Walden Procurement Area is 1,155 MCF/year.[8/] The prorated weight for this area can be derived from the following:

[8/] Assessment of Wood Raw Material and Wood Utilization POtential for the Lodgepole Pine and Spruce-Fir Timber Types in Colorado and Wyoming. J. Smego, R. Brenner, D. R. Betters. Rocky Mountain Range and Experiment Station Study 4251-18, p. 73.

Species	MCF[9]	Specific gravity[10]	% green moisture content[10]	Total weight (lbs×10^6)
Lodgepole pine	84,630	.38	.65	3,311
Spruce-Fir*	100,376	.34	.98	4,217
Douglas-Fir	5,416	.40	.38	187
Total	190,422			27,715

*Specific gravity and % moisture content are an approximation using Englemann spruce and white fir as a basis for calculations.

Dividing the total weight by the total MCF:

$$7{,}715 \times 10^6 \text{ lbs} \div 190{,}422 = 40{,}515 \text{ lbs/MCF}.$$

Applying this figure to the total actual cut:

$$1{,}155 \text{ MCF/year} \times 40{,}515 \text{ lbs/MCF} = 46{,}794{,}825 \text{ lbs/year}.$$

Of this total weight about 35 percent will become coarse residues, such as slabs and edgings, and 20 percent will become sawdust and shavings. The total residue mixture would be 64 percent slabs and edgings and 36 percent sawdust and shavings. However, the share of sawdust and shavings must be reduced to yield the desired mix of 75 percent chips and 25 percent sawdust and shavings mentioned earlier. This mixture can be achieved by using the full 35 percent of the actual cut that goes into wood chips, and 11.7 percent of the actual cut that goes into sawdust and shavings. Thus, the percentage to be applied to the actual cut to find the green usable weight per year is 46.7 percent. The resulting value becomes:

9/ Assessment of Wood Raw Material and Wood Utilization Potential for the Lodgepole Pine and Spruce-Fir Timber Types in Colorado and Wyoming. J. Smego, R. Brenner, D. R. Betters. Rocky Mountain Range and Experiment Station Study 4251-18, p. 71.

10/ Wood Handbook. Agricultural Handbook #72. 1955. U.S. Department of Agriculture, p. 75, 76.

Table VI. Actual Cut and Green Usable Mill Residues by Procurement Area and Cluster.

Cluster	Procurement area	Actual cut (MCF)/year	Lbs/MCF	Green usable tonnage/year
Colorado/Wyoming	Walden	1,155	40,515	10,919
	Laramie-Fox Park	148	40,939	1,414
	Saratoga	1,704	40,525	16,113
	Craig-Meeker	1,266	40,581	11,988
	Total	4,273	-	40,434
West Central Colorado	Delta-Montrose	1,203	41,082	11,532
	Eagle-Rifle-Glenwood Springs	964	40,641	9,142
	Granby-Fraser-Kremmling	1,432	40,474	13,524
	Total	3,599	-	34,198
Southern Colorado	Monte Vista-South Fork	1,923	41,343	18,550
	Durango-Dolores	1,226	41,596	11,899
	Pagosa Springs	707	41,632	6,867
	Total	3,856	-	37,316
North Central Wyoming	Cody	559	39,760	5,186
	Buffalo-Sheridan	717	40,816	6,828
	Total	1,276	-	12,014
Western Wyoming	Dubois	3,408	39,663	31,540
	Pinedale	2,708	39,589	25,014
	Afton-Freedom-Alpine	7,607	38,025	67,493
	Evanston	1,475	39,793	13,695
	Total	15,198	-	137,742

49,794,825 lbs/year × 2,000 lbs/ton ÷ 46.7% usable residues

= 10,919 tons of green residues per year.

The weight of green chips necessary to operate a small TMP mill for one year is 390 tons green chips/day × 345 days/year - 134,550 tons/year. It is evident from Table V-1 that no single procurement area of market cluster (except one) has the capacity to serve the TMP mill's demand for wood fiber. In fact, only one cluster area, Western Wyoming, could possibly supply sufficient manufacturing residues for the TMP mill to operate. This means that either the wood residues would have to be shipped in from a distance in excess of 150 miles or supplemental pulpwood logging within the procurement/cluster area would be necessary. Either option would serve to raise the cost of the wood residues, with a corresponding negative impact upon the economic feasibility of the TMP mill.

The amount of residues shown for the Western Wyoming Cluster probably represents the best possible situation for TMP in the study region. These figures, based on 1976 production, assume that firms would continue harvesting at past levels to meet a large housing construction demand, representing a maximum expected cut for the area. Based on these estimates, the Western Wyoming Cluster seems to offer the best possible site in the region in terms of mill residue availability.

Market Assessment

An existing market survey for TMP was used to determine the potential demand for TMP market pulp and price per unit for the pulp.[11/] This survey

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11/ Switzer, W. E. Professional Paper on File with the Department of Wood Sciences, Colorado State University, 1980.

included 38 paper mills within a 12-state area that produced products which perhaps could utilize TMP. A sample was drawn from the 1980 Lockewood Directory which contains names and addresses of all pulp and paper mills within the United States.

A total of 18 responses was received. Of the 18 responses, 14 were not interested, three would consider purchasing TMP only under certain conditions and one firm would be willing to purchase TMP at the present time. However, only one of the four firms considering utilizing TMP was interested in purchasing a volume (250 ADT per day) substantial enough to support a new TMP mill. The other three mills combined would only use a small percentage (10%) of the proposed TMP mill's output. The mill that indicated it would purchase 250 ADT per day mentioned that it was planning to produce its own pulp. However, if this mill could not obtain the required permits, 250 tons of pulp per day would be purchased on the open market at current market prices. This mill was located in Minnesota. The two mills closer to Colorado/Wyoming in Missoula, Montana, and Snowflake, Arizona, both replied negatively concerning market purchase of TMP.

Wood Residue Costs in Colorado/Wyoming

Wood residues often represent a cost to sawmill operators. If there is not market for them, they must be either incinerated or transported to landfills. Presently, wood residues in Colorado/Wyoming are sometimes chipped and shipped to pulp mills in the Lake States area, or occasionally, to the West Coast. In the absence of effective competition, the price of these chips usually depends upon the price offered by the buyer rather than a price demanded by the seller. Of course, the seller will not

deliver if the price is so low that he incurs an overall loss or more of a loss than the cost of disposal by some other means.

One firm selling chips in Colorado/Wyoming area receives $24/BDU.[12] A BDU is defined as 2,460 lbs. of bone dry chips. At a 95 percent conversion capability, this becomes 2,280 lbs. of final product. Thus in terms of an air dried ton of pulp, this raw material cost is $21/ADT. Another firm sells chips to a Wisconsin mill at $10/green ton.[12] Assuming 390 tons of green chips produces 190 ADT of pulp, the above value becomes $21/ADT for the raw material. Above prices are net for pulp delivered to the pulp mill. Gross delivered price would include shipping costs.

Given the present costs in disposing of residues, lack of other markets, and large transportation costs to the Lake States, it can be assumed that the TMP mill could probably purchase chips locally at $36/ADT or $18/green ton. This is the same price used in a previous TMP feasibility analysis.[7]

Estimates of local chip transportation costs are based on trucking costs presented in Chapter IV of this report. The labor and capital costs of short truck hauls dictated that the hauling costs were mostly a function of the number of trips made per day. A trucker would charge $175/load if he could make two hauls per day at a one-way distance ranging from 50 to 70 miles. Most trucks can haul up to 50,000 lbs. per haul. Assuming that 50,000 lbs. of green chips could be hauled less than 75 miles for $175, the transportation cost per ton would be $7/green ton. If the distance were extended to double the above distance, or 150 miles,

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[12] Personal contact with area lumber mills, September, 1980.

the trucker could only make one trip per day and therefore almost double the per unit cost.

The transportation costs of delivering the green chips to the plant would range from $14/ADT for a distance of 75 miles to almost double this amount at a distance of 150 miles (assuming an approximate conversion of two green tons of chips to one air dried ton of pulp). The result is that given a cost of $36/ADT for the purchase of wood chips and the distances involved in gathering the wood chips over the Western Wyoming cluster, the allowable difference for the purchase of chips f.o.b. at the sawmill would be at the most $11/greenton

[($36/ADT - $14/ADT) ÷ 2 green tons/ADT].

TMP Manufacturing Costs--Results of a Previous Study

Table V-2 shows a manufacturing cost breakdown for a TMP plant.[7/] The output of the plant in this analysis was assumed to be 300 ADT/day compared to 190 ADT/day used in this study. The manufacturing costs less the costs of the raw material are approximately $120/ADT/day. For this comparison it would be assumed that the Variable, Fixed, and Out-of-Pocket costs will have the same returns-to-scale for a plant producing 190 ADT/day as for a plant producing 300 ADT/day. Most producers experience increasing returns-to-scale meaning that unit costs go down as capital investment goes up or conversely unit costs go up as capital investment goes down. Here the assumption is that the unit costs do not change as the TMP mill size is reduced. This implies that the production costs here are probably a low estimate.

Table V-2[7/]

Estimated per-ton production costs of TMP
(based on 300 ADT/D capacity)

	Tissue grade	Newsprint grade	Magazine grade
Variable costs			
Wood chips	$ 35.93	$ 36.24	$ 37.39
Power	35.84	38.83	40.23
Gas	3.15	3.15	3.15
Chemicals	8.33	2.85	8.33
Miscellaneous supplies	2.13	2.13	2.13
Subtotal	$ 85.38	$ 83.21	$ 91.23
Fixed costs			
Labor	$ 13.25	$ 13.25	$ 13.25
Salaries	3.49	3.49	3.49
Maintenance	9.18	8.70	9.66
Boiler fuel	1.20	1.50	1.50
Insurance	2.41	2.40	2.44
Ad valorem taxes	2.82	2.81	2.85
Miscellaneous	2.45	2.45	2.45
Subtotal	$ 34.80	$ 34.60	$ 35.64
Manufacturing costs	$120.18	$117.81	$126.87
Interest and debt service	23.89	23.67	24.05
Out-of-pocket costs	$144.07	$141.48	$150.92
Depreciation	12.90	12.84	13.03
Total production costs	$156.97	$154.32	$163.95

Energy Costs - A Comparison with the Southeastern U.S.

In Table V-2 the energy cost per unit varies from 23 percent to 25 percent of the total cost. This is a significant proportion of the production costs and, in this case, it was based upon a demand for 31,500 kilowatts (KW) and an energy consumption of 18,396,000 kilowatt-hours (KWH) per month to be supplied by the Georgia Power Company.[13/] This amounts to a cost of $35.84/ADT in the case of tissue grade pulp.

To evaluate the comparative energy cost for the TMP mill in Colorado or Wyoming, the above energy figures will be reduced by the same ratio as the output of pulp from the Georgia mill is to the projected output for a Colorado/Wyoming facility. This gives a demand of 19,950 KW/month and an energy consumption of 11,650,800 KWH/month. A comparison of the present local energy rates with the present Georgia Power Company rate gives the following:[13/]

Georgia Power Company	
Monthly charge	$319,997.00
Unit charge (5,463 ADT/month)	$ 58.58/ADT
Poudre Valley R.E.A. (Colorado)	
Monthly charge	$306,084.00
Unit charge (5,463 ADT/month)	$ 56.03/ADT
Public Service Company of Colorado	
Monthly charge	$367,602.00
Unit charge (5,463 ADT/month)	$ 67.29/ADT

13/ Personal contact with Georgia Power Co. September, 1980. Contact with Public Service Co. of Colorado and Poudre Valley R.E.A. July, 1980. Contact with Electric Lincoln Service Corp., Kemmerer, Wy. October, 1980. Contact with Lower Valley Power and Light REA, Afton, Wy. October, 1980.

Electric Lincoln Service, Corp. (Kemmerer, Wyoming)	
Monthly charge	$366,259.00/mo.
Unit charge (5,463 ADT/month)	$ 67.04/ADT
Lower Valley Power and Light REA (Afton, Wyoming)	
Monthly charge	$311,197.00/mo.
Unit charge (5,463 ADT/month)	$ 56.96/ADT

A major finding here is that there does not seem to be a significantly lower cost, as anticipated, for electric power in the Colorado/Wyoming area. Instead, the rates seem to be the same or even higher than in the Southeast.

Pulp Shipping Costs and Market Prices

Assuming that woodpulp would be shipped from Kemmerer, Wyoming, to Minneapolis, Minnesota, the rate quoted by the Union Pacific Freight Rate Office was $3.34/100 lbs. for wood shavings, the closest similar commodity.[14/] This becomes $66.80/ADT. The possibility of a negotiated rate exists if volumes are sufficiently large.

The pulp prices that were quoted in the survey ranged from $150/ADT to $315/ADT. The most frequently quoted price was $200/ADT. The feasibility study cited for Table V-2 also used a price of $197/ADT for projected 1980 revenues. This lends further support for using $200/ADT as an estimated market price.

Economic Analysis

In an economic analysis the maximum production cost that can be allowed for the TMP mill to break even was derived; that is, where the

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14/ Personal contact with Union Pacific R.R. rate office in Denver, Colorado. September 1980.

total costs equaled the total revenue. The method of obtaining this value was to set the revenue per unit equal to the sum of the costs per unit for raw material procurement, transportation of the pulp to the market, and the manufacturing cost of producing pulp. The costs and prices derived were:

Revenue = $200/ADT

Raw material costs = $36/ADT

Product transportation costs = $66.80/ADT.

Thus the breakeven point becomes

$200/ADT = $36/ADT + $66.80/ADT + $97.20/ADT.

From this it can be stated that if the TMP can be manufactured at a cost less than $97.20/ADT, including profit and risk, it may be economically feasible to establish a TMP mill in the Western Wyoming Cluster area.

The previous study estimated manufacturing cost to be approximately $120/ADT. Thus the raw material and transportation to market costs for the Wyoming TMP mill are too high to allow enough of a residual to cover manufacturing costs given a selling price of $200/ADT. The costs are definitely too high to allow an adequate return for profits.

Conclusions

No areas except the Western Wyoming Cluster area produce enough sawmill residues to meet the TMP mills raw material needs. It is important to note that, as previously shown, the output given in the Western Wyoming area is a "peak" output rather than an average yearly output that could be depended upon. This production of lumber and, as a result, mill residues is sensitive to housing construction levels which have fluctuated widely

in the recent years. Given this present mill residue situation, along with a questionable future growth in residue output, and no sufficient "cushion" or alternative low-cost raw material, it would seem that the raw material availability would make the TMP mill establishment a "risky" endeavor. Further, if the mill found it necessary to harvest pulpwood, this would serve to raise the raw material cost considerably. The raw material costs used in this analysis must be considered low estimates.

The energy cost is a significant part of the production cost of TMP. It was anticipated that the cost of electricity in the Colorado/Wyoming area would be sufficiently lower than that in the Southeastern United States to create a significant cost advantage. But in the case of the Georgia Power Company, the Colorado/Wyoming electrical rates are equal to, if not higher than, the rate in the Southeastern United States. Therefore, there seems to be no cost advantage in the energy area.

Presently, the only feasible market for TMP is a paper mill in the Minnesota area. The closer Montana and Arizona paper mills indicated no need or interest in purchasing TMP. Given this long shipping distance, the expected delivery costs of the pulp are quite large, 33% of the total cost at the breakeven point, making the operation even more marginal.

The manufacturing figures given in Table V-2 can be considered low when compared to the Colorado/Wyoming case for several reasons. First, energy costs used were below those presently in effect in this area. Second, the fixed costs of the smaller Colorado plant would probably yield a higher per unit cost than those given in the table. Third, the costs of obtaining wood residues would probably be higher than $36/ADT ($18/green ton). Even using these low estimates for a Colorado/Wyoming TMP facility, the cost of approximately $120/ADT is still above the maximum

allowable production cost of $97.20 for the Colorado/Wyoming mill in the breakeven analysis.

All the above would lead to the conclusion that, under present circumstances, a TMP mill in the Colorado/Wyoming area is not economically feasible.